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Further Trends in Work-Related Musculoskeletal Disorders-A Comparison of Risk factors for Symptoms Using Quality of Work Life Data From the 2002, 2006 and 2010 General Social Survey

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Abstract

Objective—Report trends for risk of musculoskeletal disorders (MSDs).

Methods—Three QWL surveys examine the risk factors for MSDs.

Results—Findings similar for several risk factors, but differences across the reporting years may reflect economic conditions. 2010 respondent numbers were reduced, some risk factors had pattern changes and there were gender and age differences. Trend analysis showed most significant changes were for the “Work Fast” risk factor. New 2010 “Physical Effort” item showed gender differences and items reflective of total worker health showed strong associations with “Back Pain” and “Pain in Arms.”

Conclusions—Intervention strategies should focus on physical exposures and psychosocial risk factors (work stress, safety climate, job satisfaction, supervisor support, work fast, work freedom, work time) that have been consistently related to reports of MSDs. Economic conditions will influence some psychosocial risk factors.

Introduction

This report continues the analysis of the National Institute for Occupational Safety and Health (NIOSH) Quality of Work Life (QWL) survey of risk factors for musculoskeletal disorders (MSDs). The QWL data were collected as part of the General Social Survey. Previous analysis of risk factors in the 2002[12] and 2006[17] data collections have shown significant relationships with exposures to physical and psychosocial factors and symptoms of MSDs. Using data collected in 2010 and comparing the results with previous surveys that

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used the same methodology provides a 10 year period for evaluation of risk factors for MSDs.

Since the previous publication of the QWL data additional studies have appeared in the literature that continued to identify significant risk factors for MSDs and extend the breadth of MSD research to additional countries, occupations, and paradigms (e.g., absenteeism/presenteeism). Systematic reviews have also been published that have evaluated intervention techniques/strategies to prevent the occurrence of MSDs. Brief reviews of these studies are presented below.

Kausto et al[1] reported physical and psychosocial risk factors for MSDs in a Finnish population of 2,491 men and 2,613 women as part of a survey conducted in 2000-2001. Men were more often exposed to high physical work load factors and other co-occurring work load factors than women, but there were also age differences. For men peak physical work load factors occurred before age 30, but for women after age 50. Younger ages in both men and women were associated with low job control and additionally for women, low social support.

Eatough et al[2] investigated the effects of psychological strain (i.e., individual maladaptive responses to environmental demands or stressors that may have emotional components) on the reports of work-related musculoskeletal complaints using a web-based survey from 277 full-time employees that worked primarily in retail/service, professional (e.g., nurse, teacher), and technical fields. High levels of psychosocial work stressors (high role conflict, low job control and low safety-specific leadership) were associated with increased psychological strain which led to higher levels of work-related musculoskeletal symptoms of wrist/hand, shoulder, and lower back.

Eltayeb et al[3] conducted a prospective cohort study of Dutch computer office workers to investigate associations of work-related physical and psychosocial variables on neck, shoulder and forearm/hand complaints. Baseline data was collected on 268 respondents with follow up data collected at 24 months on 98% of initial respondents. Significant predictors for neck and shoulder complaints were: (1) irregular head and body posture; (2) task difficulty (job demand); (3) number of working hours/day; (4) previous history of complaints. Predictors for forearm/hand complaints were: (1) time pressure (job demands); and (2) previous history of complaints.

Riley et al[4] did not find any significant correlations between task repetition (lifting/loading/unloading), low back pain and 10 psychosocial factors in a study of parcel delivery drivers in Taiwan. The psychosocial factors were: (1) quality of life; (2) physical domain; (3) psychological domain; (4) social relationships; (5) environmental domain; (6) job dissatisfaction; (7) lack of autonomy; (8) lack of encouragement; (9) job stress; and, (10) poor interpersonal relationships.

Nordlander et al[5] reported results from studies (1986-2005) that used similar exposure measurement methods on psychosocial risk factors and musculoskeletal elbow and hand disorders. Eight groups of male workers (n=761) and 19 groups of female workers (n=1891) were in the combined data set. Final models showed wrist angular velocity was the most

consistent physical exposure variable being associated with pain and discomfort complaints in the past 12 months and for diagnosed disorders (Epicondylitis, and Carpal Tunnel Syndrome). Low job control was the most significant psychosocial risk factor associated with complaints for both the past 12 months and within the past 7 days.

Joling et al[6] using electronic questionnaires analyzed MSD complaints from a longitudinal three-phase study of Dutch workers over a three year period (2004-2006). Questionnaires rated pain or discomfort in neck, shoulders, elbows, wrists, hand and back in the previous 12 months. Psychosocial risk factors included work dedication, decision latitude, coworker support, supervisor support, quality of communication and job demands. Strongest predictors of MSD risk was the existence of disorders the previous year and quality of communication.

Articles relating MSDs to work productivity effects have also appeared. Absenteeism refers to lost work time. Presenteeism refers to presence at work but not at full capacity. Canjuga et al[7] reported work-related MSDs and absenteeism (i.e. sick leave) from 2849 workers who participated in face-to-face interviews in German speaking countries. Sick leave was determined by responding to the question “Over the past 12 months, how many days in total were you absent from work for reasons of health problems?” Work related backache and/or muscular pain in shoulders, neck and/or upper/lower limbs were selected outcome measures. Twenty per cent of responders reported MSDs in the past 12 months but only 7% attributed absences to MSDs. Risk factors with the strongest relationships were “tiring or painful working position” and ability to “choose or change the speed or rate of work.” Shiri et al[8] compared workers that were either on full or part time sick leave. The part-time sick leave was considered an intervention and workload was reduced by restricting work time by about half. The full time sick leave group did not work. The outcome measures were: (1) pain intensity; (2) body region specific disability; (3) general health; (4) quality of life; (5) depression; (6) sleep disturbance; and, (7) productivity loss. Results showed that the two groups did not differ on reports of pain intensity, pain interference with work and sleep, body region disability, productivity loss, depression or sleep disturbance. The intervention (part-time sick leave) group reported better self-rated general health and health-related quality of life. Campo and Darragh[9] studied the effects of work-related musculoskeletal disorders on presenteeism. Members from the American Physical Therapy and American Occupational Therapy Associations who were currently working and reporting a work-related musculoskeletal disorder (WMSDs) within the past four weeks were selected for the study. Questionnaires measured pain intensity for nine body regions and were dichotomized into minor and moderate for comparison on the presenteeism measures. Presenteeism was measured using the Stanford Presenteeism Scale (SPS) which provides a Work Output Score (WOS) and a Work Impairment Scale (WIS). WMSDs were significantly associated with reductions in both measurements of presenteeism. Body regions most affected were neck, wrist, hand and low back.

A study that evaluated technical and administrative changes at the worksite as an effective intervention for upper extremity disorders was reported by Martimo et al[10]. Workers (N=177) were randomly assigned to either the intervention or control group. Initial baseline interviews established work site physical exposures and questionnaires evaluated job strain,

medical history, physical activity, fear-avoidance, and smoking history. Assessments by an occupational physiotherapist specified the interventions. The primary outcome measure (self-assessed productivity loss at work) was assessed with specific questions designed to evaluate the effect of upper extremity symptoms on work performance. Results showed that productivity losses were lower in the intervention group at both the 8 and 12 week period but only statistically significant at 12 weeks. Pain intensity showed no differences between the two groups at 12 weeks.

In recent years systematic reviews, which, apply inclusion/exclusion criteria to select high quality studies for review have appeared in the literature. The da Costa and Vieira[11] review was in our previous publication (Waters et al[12]) and reported the biomechanical and psychosocial risk factors with reasonable evidence for a causal relationship with MSDs. Three other recent systematic reviews are summarized below.

Two systematic reviews from Germany reviewed only longitudinal studies for evidence of significant physical exposures (Mayer et al[13]) and psychosocial risk factors (Kraatz et al[14]) associated with development of neck and shoulder disorders. Twenty-one articles were located for extensive review in the Mayer study and 18 in the Kraatz study. Levels of evidence (e.g., strong, moderate, insufficient) were assigned based on the number of studies reporting similar findings and the methodological quality of the studies. For the physical exposures study, strong evidence was reported for neck and shoulder complaints with: (1) manual material handling (MMH); (2) repetition; (3) trunk flexion; (4) working with hands above shoulder level; (5) awkward postures; and (6) vibration. Insufficient evidence was reported for sitting, neck flexion and neck rotation. In the psychosocial risk factors study, results showed strong evidence for neck and/or shoulder complaints with: (1) job demand; (2) job control; (3) job strain; and, (4) social support. Insufficient evidence was determined for job satisfaction, mental stress and other organizational work factors. Combining risk factors the findings showed that high job demands, low job control, low social support and high job strain (high job demand/low job control) showed strong evidence of effects on neck and/or shoulder disorders.

Long et al[15] reviewed studies on the incidence and prevalence of upper extremity MSDs among midwives, nurses and physicians. After applying Inclusion/Exclusion criteria and rating the studies for quality, 29 met the full inclusion criteria. All but one study used the Kuorinka developed Standardized Nordic Musculoskeletal Questionnaire (NMQ). The median annual prevalence for work-related neck, shoulder, and upper back musculoskeletal disorders ranged from 35% to 45%. The neck (45%) was the body region with the highest rate.

Production techniques in relation to MSDs have not received much attention, but a recent study by Brännmark and Håkansson[16] on lean production is interesting. Lean production refers to production techniques that include Just-in-Time-production, 5S/housekeeping, waste reduction, production balancing, standardization, reduced set-up times and continuous improvements. 5S refers to a workplace organization approach that roughly translates (Japanese) to “sort”, “straighten”, “shine”, “standardize”, and “sustain”. Twenty-three publications were identified and WMSD measurements were included in eight articles and

18 publications included measurements of WMSD risk factors. A small number of studies of varying quality and with no standard definition of lean production made comparing results difficult to draw conclusions. There was a tentative conclusion that lean production may increase the risks of WMSDs and that ergonomic interventions should be implemented that focus on reducing monotony and repetitiveness.

The objective of the present study continues the examination of risk factors that have been related to the occurrence of upper and lower extremity Musculoskeletal Disorders (MSDs). The same questionnaire items (Waters et al[12], Waters et al[17]) used in the previous data collections (2002 + 2006) were administered, but some additional items were added. The previous surveys only rated the two exposure measures, " heavy lifting" and "hand movement" with a dichotomous yes/no choice, making it difficult to estimate a quantitative physical load. A new question has been added that rates the physical effort at the job from Very Light to Very Hard on a 5-point Likert scale. Because this is a new question the responses are only available for the 2010 data collection. Three additional responses on physical health days, mental health days and total health days have been added as indicators of total worker health. These responses were available as part of the GSS core module so data from all three survey years is reported. All other questionnaire items remain the same as appeared in the previous publications and the four new questionnaire items with response choices are shown in Appendix I. Tables II and III have the item questions abbreviated in parenthesis after the Risk Factor.

Materials and Methods

The 2010 QWL data were collected in General Social Survey (GSS). The GSS is a sociological survey used to collect data on demographic characteristics and attitudes of residents of the United States. The survey is conducted face-to-face with an in-person interview (90 minutes) by the National Opinion Research Center at the University of Chicago. Similar to the previous surveys (2002 and 2006) the target population is US adults over 18 years of age, randomly selected, non-institutionalized, and capable of speaking English. Details regarding the GSS survey methods are available on the Web at: http:www.norc.org/GSS+website/. In addition to the GSS core module, the National Institute for Occupational Safety and Health (NIOSH) has added a Quality of Work Life module since 2002 which is collected from individuals who indicated they were employed or self-employed for pay in the week prior to the survey (www.cdc.gov/niosh/topics/stress/qwlquest.html). Individuals were required to be working > 20 hours a week and those currently missing work due to vacation, illness or on strike were also included. Final sample size in 2010 was 1019, which was much lower than the previous surveys (2002=1455; 2006=1537). The smaller sample may, in part, be due to higher levels of unemployment during the recession that was occurring when the 2010 sample was collected because the GSS survey samples roughly the same number of respondents each year.

Selection of the individual, physical and psychosocial variables from the core GSS survey and the QWL module remain the same for the 2010 analysis as in the previous surveys, except for the item additions listed in the introduction. Items with continuous distributions (e.g., age, work hours, years of employment) were re-categorized into smaller ranges. Two

items with highly correlated response choices were combined to create the risk factors "Supervisor Support," and "Safety Climate" to remain the same as in the previous analysis. Pearson chi-square tests were used to compare the outcome measures of arm and back pain for the occupational categories across the survey years. Risk factor ORs were calculated using univariate logistic regression, and multivariate, stepwise regression was used to identify statistically significant bivariate interactions. All univariate factors were forced into these models. To calculate the ORs for the bivariate interaction the levels of two variables were combined into one variable and univariate regression performed. Significant values in tables II and III use 0.05 for confidence limits that do not include 1.0 Additional details of statistical methods can be found in Waters et al[12, 17]. The new items (physical health days, mental health days and total health days) were re-categorized dichotomously to 0-13 and ≥ 14 days. The addition of the "physical effort" item added a two factor interaction for comparison on the outcome variables. This variable was also dichotomized for the analysis of risk factor combinations. All calculations were done with SAS® (Version 9.3, SAS Institute, Inc., Cary, NC).

An additional logistic regression analysis was performed to determine the significance of trends over the 3 QWL data reporting years. This analysis included year as a continuous variable, a risk factor, and the year × risk factor interaction. All risk factors and combinations were tested using a Wald chi-square as the test statistic and only values with p values < 0.1 are reported. Non-significant p values indicate that there was no increasing or decreasing trend in the ORs over the years of that the trends among levels of a risk factor were not different. Two risk factors, "Must Work" and the dichotomized "Work Fast" factor were further analyzed for trend by occupational category using a year × risk factor × occupation interaction to determine if the trend in the odds ratios of a risk factor varied by occupation.

Results

The GSS survey is usually conducted from mid-March to mid-September but in some years is extended to complete the survey targets. Unemployment rates, as reported by the Bureau of Labor Statistics (U.S. Department of Labor[18]), for these months averaged from 5.77 % in 2002, 4.64% in 2006 and 9.61% in 2010. Overtime hours, which can be an indicator of productivity demands, also showed marked fluctuations. This data (http://www.bls.gov/ces/#tables), which is reported in the manufacturing sector, averaged 4.10 hours per month in 2002 (3 months, July, August, September), 4.44 hours in 2006 (March-September) and 3.81 hours in 2010 (March-September).

Table I presents the frequency results for the outcome measures "Back Pain" and "Pain in Arms" by eight occupational classifications for all 3 QWL data collection years. These 8 classifications are used to be backward compatible with the NIOSH 1977 Quality of Employment Survey (QES), thus allowing comparisons of worker responses over a 37-year period. Unlike the previous survey years the reports of "Back Pain" in the 2010 survey did not differ significantly ($X^2 = 9.67$, $df = 7$, $P = 0.208$) by occupational classification, probably due to lower reports of "Back Pain" in all occupational classifications. Similar to the 2006 analysis, but not the 2002 analysis, the reports of "Pain in Arms" by occupational

classification was significant (X^2 = 19.41, *df* = 7, *P* = 0.007). Occupational categories service, farming/forestry/fishing, precision production/craft/repair and operators/fabricators/laborers had the highest reports of "Back Pain" while managerial/administrative and professions had the lowest. With 'Pain in Arms," highest reports were similar except that managerial/administrative was high and technical/sales low. Chi-square analysis, however, showed that reports of "Back Pain," "Pain in Arms," and both "Back Pain," and "Pain in Arms" by occupational classification between the 3 QWL survey years did not differ significantly.

The percentage of interviewees reporting yes to "Back Pain" and "Pain in Arms" is consistent across the 3 reporting years. For "Back Pain" the percentages are 27.90%, 27.98% and 25.32% for the 2002, 2006, 2010 years respectively. For "Pain in Arms" the percentages are 27.99%, 27.80% and 27.48%. The percentage of interviewees reporting yes to both "Back Pain" and "Pain in Arms" is also very stable (15.34% [2002]; 15.23% [2006]; 15.60% [2010].

Figure 1 provides an illustration of the "Physical Effort" by occupational classification. The occupations reporting the greatest physical efforts are the less sedentary and require more manual tasks and labor (e.g., farming/forestry/fishing, precision production/craft/repair, operators/fabricators/laborers). Figure 2 shows the reports of "Back Pain" and "Pain in Arms" by the "Physical Effort" ratings of the interviewees required at their work. The greater the rating of "Physical Effort" the greater the percentage of "yes" reports of "Back Pain" and "Pain in Arms." Gender differences were also significant with the ratings of "Physical Effort," (X^2 =26.07, *df* = 4, P = 0.0001) which are illustrated in Figure 3. Females reported less "Hard" (X^2 =7.22, *df* = 1, P = 0.007) or "Very Hard" (X^2 =10.06, *df* = 1, P = 0.002) effort at the job but higher reports of "Very Light" (X^2 =1.391, *df* = 1, P = 0. 238) and "Fairly Light" (X^2 =12.508, *df* = 1, P = 0. 0004) effort. Reports of "Somewhat Hard" (X^2 =0.544, *df* = 1, P = 0. 461) were roughly equal but higher percentage wise for males. These differences are further illustrated in Figure 4, which shows that representation of males is greater in occupations rating more physical effort which are farming/forestry/fishing, precision production/craft/repair and operators/fabricators/laborers.

Back Pain

Table II presents the frequency responses and the Odds Ratios (ORs) and 95% Wald confidence limits for the 2002, 2006 and 2010 reporting years for each risk factor. Significant values are in bold.

Individual Factors

Similar to 2002 and 2006, there were no significant ORs for the "Age" or "Gender" factors. The 2010 "Hurt at Work" factor showed significant ORs at all three response. Greatest risk (OR 3.49, 95% CI 1.46-8.32) for reporting back pain in the 2010 data was "hurt at work" 3 times or more within the past year. The individual risk factors for "Physical Health," "Mental Health," and "Healthy Days" all showed significant relationships with reports of "Back Pain" for all three QWL reporting years. In 2010 the OR for "Physical Health" was

4.05 (95% CI 2.53-6.48), for “Mental Health” 3.73 (95% CI 2.50-5.58) and “Healthy Days” 3.73 (95% CI 1.99-6.96).

Physical Factors

Consistent with both the 2002 and 2006 analysis two physical exposure risk factors “Heavy Lifting” and “Hand Movement” were significant in the 2010 data set. The OR for “Heavy Lifting” was 1.56 95% CI 1.17-2.05 and for “Hand Movement” the OR was 1.86 95% CI 1.41-2.47. The “Physical Effort” item was highly significant with ORs greater at each increased rating step. Ratings of “Very light” and “Fairly light” were not significant, but ratings “Somewhat hard” (OR 1.59, 95% CI 1.06-2.40), “Hard” (OR 2.28, 95% CI 1.40-3.69) and “Very Hard” (OR 3.79, 95% CI 2.29-6.26) were significant. Figure 1 graphically presents the results for the “yes” responses to “Physical Effort” and “Back Pain.”

Psychosocial Factors

Table II shows that psychosocial factors with significant relationships to “Back Pain” in the 2010 data set were generally consistent with the previous reporting years. These factors included “Job Satisfaction,” “Supervisor Support,” “Safety Climate,” and “Work Stress,” although the strength of the risks as indicated by the ORs showed some fluctuation. The two most noticeable changes were with “Supervisor Support” and “Work Stress.” In the 2002 and 2006 data sets only one response choice that represented lack of supervisor support was significant, but in 2010 both the “Not too true” (OR 1.88, 95% CI 1.25-2.83) and “Not at all true” (OR 3.06, 95% CI 1.71-5.48) were significant. “Work Stress” showed a weaker effect on “Back Pain” as only the “Always” response choice was significant (OR 2.81, 95% CI 1.33-5.91) whereas in both 2002 and 2006 both the “Always” and “Often” were significant. One significant relationship that had not appeared in the previous data sets was with “Work Schedule.” The response choice “Rotating Shift” was significant for “Back Pain” (OR 3.13, 95% CI 1.70-5.78).

Non-significant relationships were also fairly consistent but there were some changes. “Work Time” was not significant in 2010 but had shown a significant relationship in both the 2002 and 2006 data set for the response “Not at all true.” “Work Freedom” which had shown a protective effect in the 2002 data set was not significant with either the 2006 or 2010 data set. “Work Fast” and “Work Hours” were not significant in 2010 which was consistent with the 2006 data set and only one response category (Choice 51-60h) was significant in 2002. “Must Work” which was significant in both the 2002 and 2006 data sets was not significant in 2010 (OR 1.17, 95% CI 0.87-1.58).

Table II shows the results for the psychosocial factors that were dichotomized into yes/no responses. Consistent with the 2002 and 2006 analysis, “Job Satisfaction” (OR 2.33, 95% CI 1.57-3.46), “Safety Climate” (OR 0.45, 95% CI 0.30-0.69) and “Work Stress” (OR 1.73, 95% CI 1.31-2.30) were significant for increased reports of “Back Pain.” “Work Fast” which was not significant in the 2002 and 2006 analyses was significant in 2010 (OR 1.67, 95% CI 1.22-2.30). “Work Time” was not significant in 2002, was significant in 2006, but then not significant in the 2010 analysis (OR 0.83, 95% CI 0.58-1.20).

The risk factor combinations analysis, which is also in Table II, generally follows the same pattern as the 2002 and 2006, although the strength of the combinations on “Back Pain” was lessened. “Heavy Lifting” and “Work Stress” ORs are significant at all three response choices and although the 2010 response choice for “yes” to “Heavy Lifting” and “yes” to “Stress” was the lowest it was not a significant trend (X^2 = 3.25, *df*=3, P=0.354). “Heavy Lifting” and “Work Fast” showed only one significant OR (yes-yes-2.36, 95% CI 1.530-3.715), whereas in 2002 and 2006 the yes-no response choice was significant. This change was significant for trend (see below). In 2010 the ORs for “Heavy Lifting” and “Work Time” follow the same pattern as the 2002 analysis and only differ by one response choice (no-no) from the 2006 data set.

The significant interaction reported for “Hand Movement” and “Work Stress” in the 2006 data set was not significant in the 2010 data set (OR 0.97, 95% CI 0.47-2.00). All three response choices have significant ORs and the pattern is additive, which is similar to the 2002 analysis. The 2010 change appears to be due the drop in the number of reports of “yes” to both “Hand Movement” and “Work Stress.” In 2006 the per cent of “yes” reports was 47.2% but in 2010 it was 37.1% (See Table II). Similar to the “Back Pain” results, “Hand Movement” and “Work Fast” is significant at only the “yes-yes” choice (OR 2.84, 95% CI 1.83-4.43) in 2010 whereas it was significant at the “yes-no” choice in 2002 and 2006. The 2010 significant ORs for “Hand Movement” and “Work Time” are on the same response choices (“yes-no” and “yes–yes”) as the 2002 and 2006 data sets.

The “Physical Effort” item was dichotomized to create an additional comparison for a physical exposure variable and psychosocial risk factor. This dichotomization combined response choices 3, 4, and 5 (somewhat hard, hard, very hard) as “yes” and 1 and 2 (very light, fairly light) as “no.” The ORs for “Physical Effort” and “Work Stress” were significant at all three response choices for “Back Pain.” The OR for “no” to “Physical Effort” and “yes” to “Stress” was 1.89 (95% CI 1.23-2.89). The “yes” to “Physical Effort” and “no” to “Stress” OR was 2.17 (95% CI 1.49-3.15) and the “yes-yes” OR was 3.53 (95% CI 2.34-5.33). One response choice, “yes” to “Physical Effort” and “yes” to “Work Fast” showed a significant OR (3.05, 95% CI 1.95-4.78) for that combination. The combination of “Physical Effort” and “Work Time” had two significant ORs. The OR for “yes” to “Physical Effort” and “no” to “Work Time” was 1.58 (95% CI 1.16-2.25) and for the “yes-yes” choice the OR was 1.90 (95% CI 1.12-3.20).

Trend analysis showed that the “Work Fast” risk factor when combined with either “Heavy Lifting” (X^2 =7.25, *df* = 3, P = 0. 0.064) or “Hand Movement” (X^2 =8.47, *df* = 3, P = 0. 0.037) was significant for “Back Pain”. With “Heavy Lifting,” the OR increased over the years for “no” to “Heavy Lifting” and “yes” to “Work Fast” and “yes” to both “Heavy lifting” and “Work Fast”, but decreased for “yes” to “Heavy Lifting” and “no” to “Work Fast.” The same pattern also existed for the “Hand Movement” and “Work Fast” combination. The “Work Fast” risk factor, when dichotomized, showed a significant increase of the OR (X^2 =3.95, *df* = 1, P = 0. 0.047). The “Must Work” factor was not significant (X^2 =2.26, *df* = 1, P = 0.133), but the estimate −0.036 indicated a decreasing trend. There was also an increasing trend for “Mental Health” (X^2 =3.00, *df* = 1, P = 0.083).

The analysis for trend by occupation for "Work Fast" was not significant (X^2 =4.55, *df* = 7, P = 0.715) and there were no significant trends for any occupational category. The analysis for "Must Work" was not significant (X^2 = 9.27, *df* = 7, P = 0.234), but there was one significant trend (0.95, 95% CI 0.75-0.97) for the Managerial and Administrative category, which indicates a decrease in the ORs of "Back Pain" over the years.

Pain in Arms

Table III reports the results for the "Pain in Arms" outcome measure. Significant values are in bold.

Individual Factors

Unlike the 2002 and 2006 analysis, there were significant "Age" and "Gender" differences in 2010. In the 45-54 age grouping there were less (27.6%) reports of "pain in arms" (OR 1.99, 95% CI 1.03-3.84) than in 2002 (32.0%) and 2006 (31.2%), whereas for the 55-64 age grouping there were more reports (33.5%) in 2010 (OR 2.25, 95% CI 1.14-4.45) than in 2002 (31.3%) and 2006 (31.6%). Gender differences were also significant (OR 1.39, 95% CI 1.05-1.82) with females reporting more "Yes" responses (30.7%) to "Pain in Arms." The 2010 "Hurt at Work" factor showed significant ORs at 2 of 3 response levels which were different than 2002 and 2006 when all three response levels were significant. Greatest risk (OR 4.78, 95% CI 1.96-11.67) for reporting "pain in arms" in the 2010 data was at "hurt at work" 3 times or more within the past year. The individual risk factors for "Physical Health," "Mental Health," and "Healthy Days" all showed significant relationships with reports of "Pain in Arms" for all three QWL reporting years. In 2010 the OR for "Physical Health" was 5.88 (95% CI 3.60-9.59), for "Mental Health" 3.06 (95% CI 2.05-4.57) and "Healthy Days" 5.77 (95% CI 2.99-11.14).

Physical Factors

Consistent with both the 2002 and 2006 analysis the two physical exposure risk factors "Heavy Lifting" and "Hand Movement" were significant in the 2010 data set. The OR for "Heavy Lifting" and "Pain in Arms" was 1.65 (95% CI 1.17-2.05) and for "Hand Movement" and "Pain in Arms" the OR was 2.83 (95% CI 2.14-3.76). The "Physical Effort" item added for the 2010 analysis was significant with ORs significant at "Hard" (OR 2.44, 95% CI 1.52-3.93) and "Very hard" (OR 5.54, 95% CI 3.35-9.14) response choices. Ratings of "Very light", "Fairly light" and "Somewhat hard" were not significant.

Psychosocial Factors

The results listed in Table III for the 2010 data set are generally consistent with the previous reporting years. Factors such as "Job Satisfaction," "Supervisor Support," "Safety Climate," "Work Freedom" and "Work Stress," had significant ORs with "Pain in Arms", although the strength of the ORs changed. Noticeable changes were with "Job Satisfaction" and "Supervisor Support." "Job Satisfaction" only had the "Not too Satisfied" response choice significant (OR 2.13, 95% CI 1.31-3.44) whereas in 2002 and 2006 all three response choices were significant. With "Supervisor Support" the 2010 data set was similar to the

2002 data set with the “Not too true” (OR 2.23, 95% CI 1.51-3.30) and “Not at all true” (OR 2.02, 95% CI 1.12-3.623) responses significant. “Safety Climate” was very consistent with the response choices “Disagree” (OR 2.61, 95% CI 1.50-4.55) and “Strongly Disagree” (OR 5.03, 95% CI 2.60-9.71) significant as they were in 2002 and 2006. “Work Freedom” did show two response choices “Somewhat true” (OR 0.52, 95% CI 0.28-0.99) and “Very True” (0.050, 95% CI 0.27-0.93) significant whereas in the 2002 and 2006 data sets, only the “Very True” choice was significant. “Work Stress” was similar to the 2006 results with both the “Often” (OR 2.15, 95% CI 1.04-4.45) and “Always” (OR 4.81, 95% CI 2.20-10.51) choices significant, although in 2006, the choice “Sometimes” was also significant.

Non-significant relationships for other psychosocial risk factors with “Pain in Arms” were also fairly consistent across all three reporting years although there were some changes. The “Not at all true“ choice for “Work Time” was not significant (OR 1.59, 95% CI 0.87-2.89) in 2010 but was significant in both the 2002 and 2006 data sets. “Work Fast” was not significant in 2010 which was consistent with the 2002 and 2006 data sets. “Work hours,” which has not been significant in the previous data sets, did have one significant OR for the response choice 61-70h (OR 2.10, 95% CI 1.09-4.01). “Must Work” which was significant in both the 2002 and 2006 data sets was not significant in 2010 (OR 1.04, 95% CI 0.77-1.40). “Work Schedule” had no significant ORs for “Pain in Arms” in 2010 as was true in 2002 and 2006.

Table III also shows the results for the psychosocial factors that were dichotomized into yes/no responses. Consistent with the 2002 and 2006 analysis, “Job Satisfaction” (OR 2.01, 95% CI 1.35-2.98), “Safety Climate” (OR 0.032, 95% CI 0.21-0.48) and “Work Stress” (OR 1.85, 95% CI 1.40-2.44) were significant. Two other risk factors were less consistent and were similar to the “Back Pain” results. “Work Fast” which was not significant in the 2002 and 2006 analyses was significant in 2010 (OR 1.60, 95% CI 1.17-2.17). “Work Time” was significant in 2002, and 2006, but barely non-significant in the 2010 analysis (OR 0.74, 95% CI 0.53-1.05). The risk factor combinations analysis generally follows the same pattern as in 2002 and 2006, although the strength of some of the combinations on “Pain in Arms” changed. The “Heavy Lifting” and “Work Stress” ORs are significant at all three response choices involving either “Stress” or “Heavy lifting” which was true for 2002 and 2006. “Heavy Lifting” and “Work Fast” only showed one significant OR (“yes-yes”-2.246 95% CI 1.475-3.419), whereas in 2002 and 2006 the “yes-no” response choices were also significant. Interestingly, there is a barely significant interaction (OR 1.88, 95% CI 1.01-3.49), which is primarily due to decreased reports of “Pain in Arms” for the response choice “yes” to “Stress” and “no” to “Work Fast” from 34.1% in 2002, 31.0% in 2006 to 21.9% in 2010. In 2010 the ORs for “Heavy Lifting” and “Work Time” follow the same pattern as the 2002 analysis and only differ by one response choice (“no-no”) from the 2006 data set. Similarly, the pattern for “Hand Movement” and “Work Stress” is the same as the 2002 analysis, and only differs from the 2006 analysis when the response choice “no-yes” was significant. All three response choices have significant ORs and the pattern is additive, which is similar to the 2002 analysis. The 2010 significant ORs for “Hand Movement” and “Work Fast” and “Hand Movement” and “Work Time” are on the same response choices (“yes-no” and “yes-yes”) which is similar in the 2002 and 2006 data sets.

The dichotomized combination of “Physical Effort” and “Work Stress” were significant at all three response choices for “Pain in Arms.” The OR for “no” to “Physical Effort” and “yes” to “Stress” was 2.08 (95% CI 1.38-3.14). The “yes” to “Physical Effort” and “no” to “Stress” OR was 2.13 (95% CI 1.48-3.08) and the “Yes-Yes” OR was 3.58 (95% CI 2.39-5.37). One response choice, “yes” to “Physical Effort” and “yes” to “Work Fast” showed a significant OR (2.7395% CI 1.78-4.19) for that combination. The combination of “Physical Effort” and “Work Time” had two significant ORs. The OR for “yes” to “Physical Effort” and “no” to “Work Time” was 2.66 (95% CI 1.58-4.49) and for the “Yes-Yes” choice the OR was 2.02 (95% CI 1.49-2.75).

Trend analysis showed that the combination of “Heavy Lifting” and “Work Fast” was significant for “Pain in Arms” (X^2 =8.42, *df* = 3, P = 0. 0.038). This trend was a decrease in the ORs for the response choices “no” to ‘Heavy Lifting” and “yes” to “Work Fast,” and “yes” to “Heavy Lifting” and “no” to “Work Fast” but an increase for the “yes-yes” choice. The “gender” × “year” comparison was significant (X^2 =3.10, *df* = 1, P = 0. 0.078), which indicated an increase in “Pain in Arm” reports. The “Must Work” risk factor showed a decrease in “Pain in Arm” ORs (X^2 =3.50, *df* = 1, P = 0. 0.061). The “Safety Climate” factor showed an increase in “Pain in Arm” ORs (X^2 =3.81, *df* = 1, P = 0. 0.051) which was represented by an increase in the ORs of “disagree” and “strongly disagree” when compared to “strongly agree.” The “Physical Health” factor showed a significant increase in ORs (X^2 =7.61, *df* = 1, P = 0.006) for “Pain in Arms” while the “Job Satisfaction” factor showed a decrease (X^2 =2.71, *df* = 1, P = 0.099).

The trend by occupation chi-square for “Must Work” was not significant (X^2 =3.52, *df* = 7, P = 0.832) and there were no significant trends for any occupation. The “Work Fast” Chi-square was also not significant (X^2 =8.59, *df* = 7, P = 0. 0.283), but there was one significant trend (1.16, 95% CI 1.01-1.36) for Precision production, craft and repair, which was an increase in the ORs of “Pain in Arms.”

Discussion

This study reports on the trends from 2002 to 2010 on the effect of individual, physical and psychosocial risk factors on self-reported low back pain (LBP) and upper extremity (hand/arm) pain. This report follows the same format as reported in the previous publications (Waters et al[12,17]) but some additional items have been added (see Introduction) and a trend analysis was performed on the factors with 3 QWL years of data. With this data covering a 10 year period, we have a “snapshot” of a decade that had several changes in indicators of economic conditions such as employment rates and overtime demands that seem to be reflected in the analysis of the risk factors on the outcome measures.

Reports from workers on the incidence of “Back Pain” and “Pain in Arms” are very consistent over all 3 QWL reporting periods. The % of respondents indicating “Back Pain” ranges from 25.32-27.98 and for “Pain in Arms” 27.48-27.99. The % reporting both “Back Pain” and “Pain in Arms” ranges from 15.23-15.60. Trend analysis showed that there was neither a significant increase nor decrease in reports of “Back Pain” and “Pain in Arms.”

The individual factor results for “Back Pain” were generally consistent for all three reporting years and trend analysis did not show any significant increases or decreases in reports of “Back Pain.” The pattern for the “Pain in Arms” outcome measures showed some significant changes with the 2010 data for “Age,” “Gender” and “Hurt at Work,” For the age categories “45-54” and “55-64” there were significant ORs for “Pain in Arms” in the 2010 analysis. Reasons are not clear because the % reporting “yes” to “Pain in Arms” dropped for one response category (45-54), but increased (55-64) for the other. Possible explanations might suggest that there was decreased productivity pressure in one age group and that older workers were staying in jobs longer in the other age category in 2010, but trend analysis did not indicate a significant change over the 3 QWL years. Trend analysis was significant for increased strength of the ORs for “Gender.” The pattern appeared to be more reports of “Pain in Arms” by females and less by males. Jobs requiring more physical labor may have been reduced the most in 2010, especially with the drop in housing starts, which would affect males more than females. The “Hurt at Work” factor was significant for all three reporting years at all response choices for “Pain in Arms,” except for the “2 times” response choice in 2010. The strength of the ORs for the “Hurt at Work” item has been inconsistent for all three reporting years with the ORs for “2 times” and “3 times” reversing in strength. Trend analysis, however, did not indicate a significant pattern change. Consistent separation does appear between “1 time” and “3 times” for both outcome measures.

The health risk factors ORs (e.g., Physical Health, Mental Health, and Health Days) for “Back Pain” and “Pain in Arms” were significant for all three reporting years, with the largest ORs showing with the 2010 data set. The 3 year trend analysis also showed an increase in reports of “Back Pain” with “Mental Health” days and “Pain in Arms” with “Physical Health” days. Whereas, it is difficult to determine if there is a cause/effect relationship between “Back Pain” and “Pain in Arms” with these health risk factors it does indicate that back pain and arm pain can have a significant influence on total worker health when viewed in terms of an individual's well-being.

The physical factors, “Heavy Lifting” and “Hand Movement” showed significant ORs for “Back Pain” and “Pain in Arms” for all three reporting years. The “Physical Effort” physical factor, which was only available in the 2010 data set, had significant ORs for “Back Pain” at all three response choices and for “Pain in Arms” at the “Hard” and “Very Hard” choices. The strength of the ORs increased with each increase in the response choice from “Somewhat Hard” to “Very Hard.” This is illustrated in to some extent in Figure 2, which shows the percent of respondents reporting “Back Pain” and “Pain in Arms.” Gender differences were apparent in the ratings of physical effort at work, with men reporting higher percentages of the “Hard” response choices and females reporting higher percentages of the “Light” choices (see Figure 3). Similar gender differences have been reported in a study of a Finnish worker population (Kausto et al[1]).

The results for the psychosocial factors show some consistencies with most risk factors over the 10 year data collection period, but there were some changes with the 2010 data set that may reflect the economic conditions, namely unemployment rates and overtime hours, in the work force in the late 2000s. In 2010, the number of eligible respondents was markedly lower possibly reflecting the influence of the recession on employment and there are some

risk factors that were significantly related to the outcome measures in 2002 and 2006 that were not significant in 2010. The “Must Work” factor which is an indicator of overtime was not significant for either “Back Pain” or “Pain in Arms” in 2010 when there was a drop in average monthly overtime hours when compared to 2006 and 2010. The 3 year trend analysis for “Must Work” showed a significant decrease for reports of “Pain in Arms” and there was also a decrease in trend for “Back Pain” (estimate = −0.036) but was not significant. Another indicator of high productivity demands, like “Work Fast” was significant only when dichotomized for the first time in 2010 for “Back Pain” and Pain in Arms.” Trend analysis also showed significant increases in OR patterns with the combination of “Heavy Lifting” and “Work Fast” on reports of “Back Pain” and “Pain in Arms.” Coupled with the “Must Work” factor not significant in 2010 suggests less overtime required but an increase in productivity demands on existing workers because the “Work Stress” factor was still significant. In addition, the “Work Time” factor which is an indication of enough time to get the job done and a protective effect showed no significant ORs either as a complete item or as dichotomized item in 2010 but there were significant ORs in 2002 and 2006 when the workforce was larger. Trend analysis, however, showed that the 3 year trend for “Work Time” was not significant for an increase or decrease in the ORs, so the 2010 results may be an exception. Similar suggestions on the effects of employment on the remaining employee work load have been reported by Ray and Sauter[19]. Additional analysis on two risk factors that changed in 2010, “Must Work” and “Work Fast” did not show any significant differences in trends by occupational category and year.

Risk factors “Job Satisfaction”, “Supervisor Support”, and “Safety Climate” both as a complete response item and when dichotomized (e.g., Job Satisfaction, Safety Climate) showed significant ORs for all three reporting years. The “Work Stress” factor also showed to be a very strong consistent risk factor for “Back Pain” and “Pain in Arms” in all three reporting years. When the work stress item is dichotomized the ORs were consistently significant for all three reporting years, but the 2010 ORs are slightly lower than either the 2006 and 2002 values. Trend analysis, however, did not show that any of the year to year changes were significant except for “Job Satisfaction” and only with the “Pain in Arms” outcome measure which was a decrease in OR values. These four psychosocial factors have shown to be consistent risk factors for greater reports of “Back Pain’ and “Pain in Arms” and should be considered four areas for concentrating intervention strategies for preventing back pain and pain in arms.

The risk factor combination analysis, which pairs a physical exposure variable with a dichotomized psychosocial factor, revealed some changes from the previous years. For the combination of “Heavy Lifting” and “Work Stress” on “Back Pain” all three response choices involving either heavy lifting or stress were significant, but the strength of the OR was lower for the response choice “yes” to both variables in 2010. Trend analysis for this combination did not show any significant increase or decrease in the OR values on “Back Pain” or “Pain in Arm” when paired with heavy lifting. The combination of “Heavy Lifting” and “Work Fast” also showed some changes from previous years on “Back Pain”. The choice “yes” to “Heavy Lifting” and “no” to “Work Fast” was not significant in 2010, but was in 2002 and 2006. The choice “yes” to “Heavy Lifting” and “yes” to “Work Fast” was significant for all three years. A similar pattern was also present for this combination on the

"Pain in Arms" outcome measure and the interaction was significant. Trend analysis confirms these differences. The 3 year trend for both the combination of "Heavy Lifting" and "Hand Movement'' with "Work Fast" indicates an increase in reports of "Back Pain" and "Pain in Arms" on two of the three response choices.

With the "Heavy Lifting" and "Work Time" combination the 2010 results are more similar to the 2002 results for both "Back Pain" and "Pain in Arms" with 2 response choices significant, whereas in 2006, 3 response choices were significant. This change appears to be due to the reduced protective effect of enough time to get the job done and reduced instances of heavy lifting which is represented by the choice "no" to "Heavy Lifting" and "no" to "Work Time." These year to year differences could be due to economic changes or the instability of these measures or a combination of both. Trend analysis was not significant for either an increase or decrease in the OR values.

The combinations involving "Hand Movement" also had some changes from previous years. With "Work Stress" the 2010 the results for both "Back Pain" and "Pain in Arms" were similar to the 2002 results with all three response choices showing significant ORs. The significant interaction for "Back Pain" which was present in 2006 was not significant in 2010, and was primarily due to the marked drop in "yes" responses to the choice of "Hand Movement" and "Work Stress" (47.2% to 37.1%). Trend analysis did not show a significant change in OR values across the 3 reporting years. For "Hand Movement" and "Work Fast" only the "yes-yes" OR was significant for "Back Pain". In 2002 and 2006, the "yes" to "Hand Movement" and "no" to "Work Fast" was significant but in 2010 there was a marked reduction in the percent of "yes" responses to "Hand Movement" and "no" to "Work Fast" (30.1% in 2006 to 24.3% in 2010). With "Pain in Arms" the "Hand Movement" and "Work Fast" combination was consistent over all three reporting years with both the "yes-no" and "yes-yes" choices significant. Trend analysis confirmed that the 3 year changes (increase) were significant for "Back Pain" but for "Pain in Arms" there was no significant trend.

For the combination of "Hand Movement" and "Work Time" the results for "Back Pain" and "Pain in Arms" are very similar for all three reporting years with the same response choices having significant ORs. Trend analysis did not show any significant changes to the pattern of OR values. To briefly summarize, the changes noted with the combination exposures seem related more to a drop in "yes" responses to the physical exposure risk factors. With less people being employed in 2010, jobs requiring more physical labor may have been reduced the most. To some extent, this is indicated by the largest drop in of the QWL participation sample for 2010 occurred in two occupational categories in Table 1 (Precision Production, Craft and Repair and Operator/Fabricators and laborers).

The combination of the dichotomized "Physical Effort" risk factor and the "Psychosocial" risk factors was consistent for both "Back Pain" and "Pain in Arms." With "Work Stress" all choices involving either a "yes" to Physical Effort" and a "yes" to "Work Stress" had significant ORs. With "Work Fast" only the response choice "yes-yes" was significant for both outcome measures. For "Work Time" both the "yes-yes" and "yes-no" responses had significant ORs for both outcome measures.

Conclusions

Analysis of the data from 3 QWL collection years that covers the first decade of 2000 shows a continued relationship between physical exposure variables and MSDs and is also influenced by both individual and psychosocial risk factors. The 3 year trend analysis confirms that the physical exposure risk factors have been consistent indicators for reports of MSDs and that most of the changes that may be sensitive to economic conditions probably occur with the psychosocial risk factors. The overall pattern shows that workplace exposure to heavy lifting is associated with increased reports of LBP and workplace exposure to repetitive or forceful hand movements or awkward postures are associated with increased risk of upper extremity disorders. The 2010 analysis included a new item which rated the physical effort required at the job from very light to very hard and the results showed strong associations with the ratings of very hard (OR=3.7) for “Back Pain” and (OR=5.5) “Pain in Arms” which is further confirmation of influence of the physical exposure variables. Work Stress continues to be a consistently significant psychosocial risk factor for both outcome measures. Job Satisfaction, Safety Climate, and Supervisor Support have also been significantly related to the outcome measures, but for Job Satisfaction and Safety Climate the relationship is stronger when the variable is dichotomized.

There was also some evidence that the severe recession in the late 2000s had influence on the results. The number or workers in the 2010 sample was reduced and three risk factors, “Must Work” which is an indicator of overtime, “Work Time” which is an indicator of enough time to get the job done, and “Work Fast” which is an indicator of jobs that require working fast had significant changes that could be related to economic conditions. In 2010, with reduced employment and reduced productivity demands overall (e.g., Must Work), but possibly greater productivity demands on the existing workforce (e.g., Work Time, Work Fast) because employers were not hiring and not paying overtime, but still requiring high levels of productivity from the employed workers. Changes with the “Must Work” and “Work Fast” risk factors were not significantly different between any of the eight occupational categories, so no specific occupational category was affected.

In 2010, there was also a significant gender effect on the “Pain in Arms” outcome measure, which when compared to previous years was a wider divergence between males and females reporting pain. Gender differences were also apparent in the ratings of physical effort on the job. Women report higher incidences of very light and light effort while men have higher reports of hard and very hard effort. Lastly, this report contains the results of indicators of worker health that were added in 2010 for which data was available for 2002 and 2006. The three indicators, mental health days, physical health days and total health days, were all significantly related to the outcome measures for back pain and pain in arms. Although not a direct cause and effect relationship, there is an indication of a strong association between MSDs and total worker health.

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Appendix I. Questionnaire items new for the 2010 survey

1. Please rate the overall physical effort at the job you normally do. (1) Very hard; (2) Hard; (3) Somewhat hard; (4) Fairly light; (5) Very light.
2. Now thinking about your physical health, which includes illness and injury, for how many days during the past 30 days was your physical health not good? Valid values: 0-30
3. Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good? Valid values: 0-30.
4. During the past 30 days, for about how many days did your poor physical or mental health keep you from doing your usual activities, such as self-care, work, or recreation? Valid values: 0-30.

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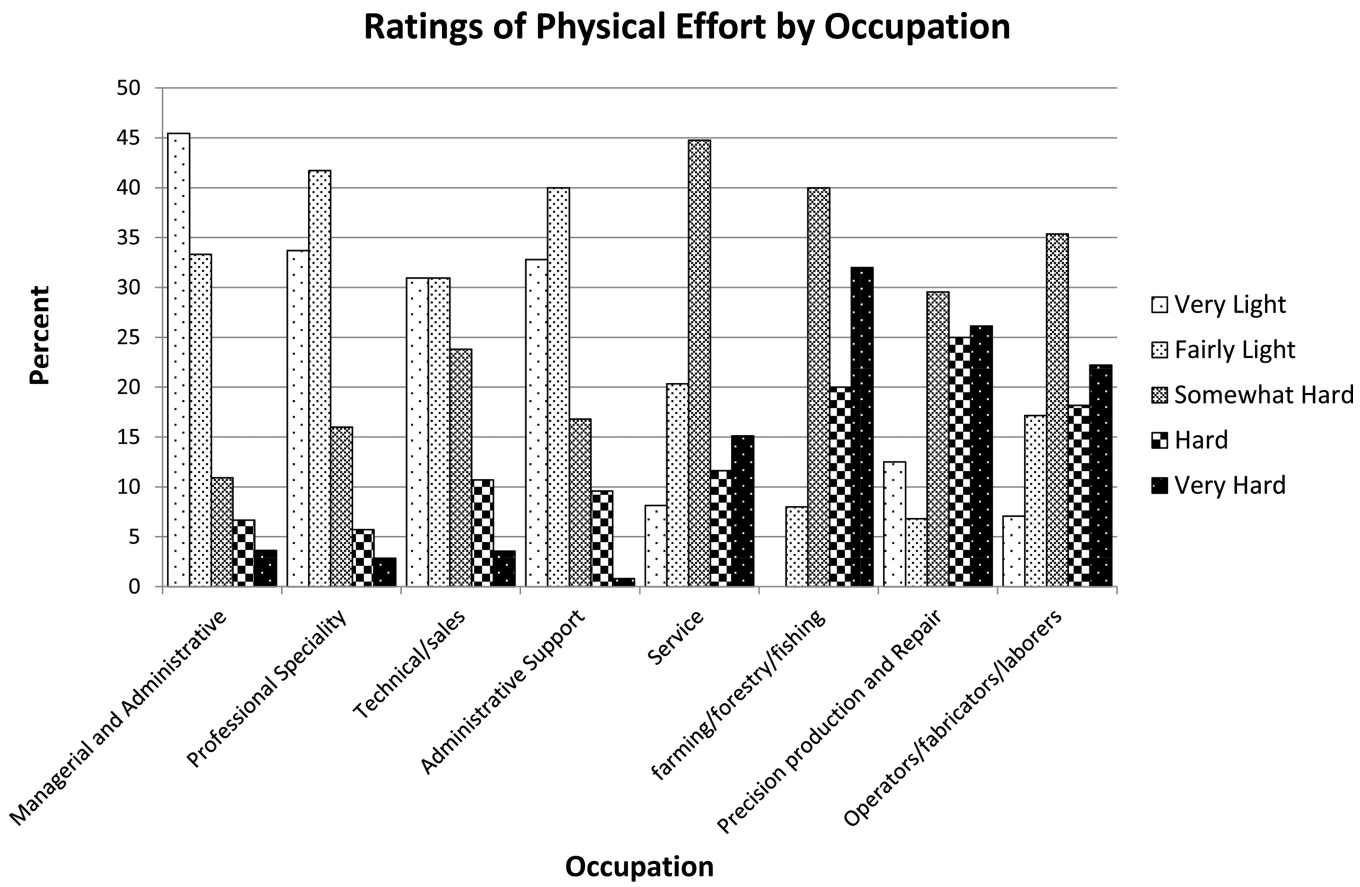

Figure 1.
Ratings of Physical Effort by Occupation.

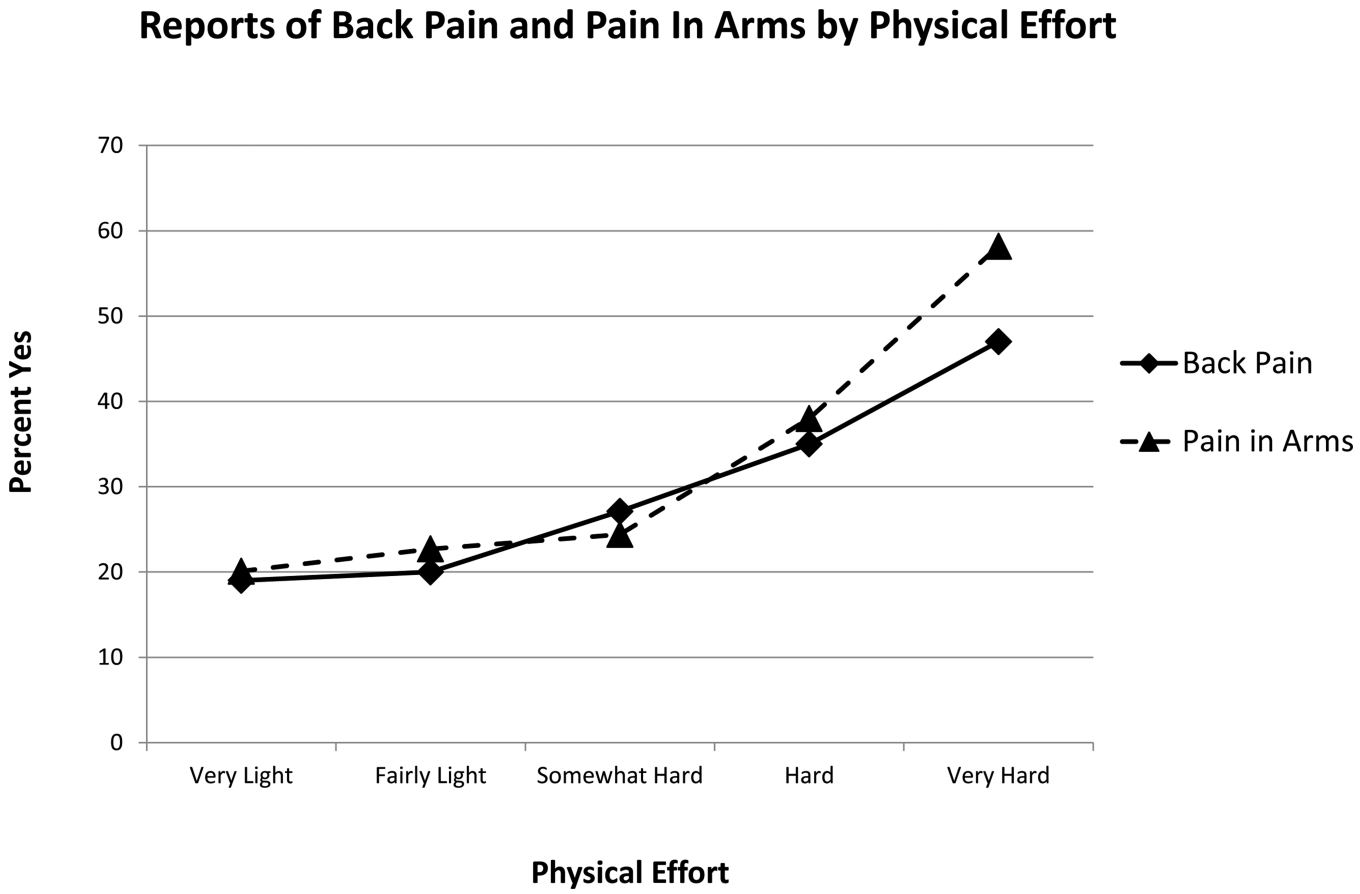

Figure 2.
Reports of Back Pain and Pain in Arms by Physical Effort.

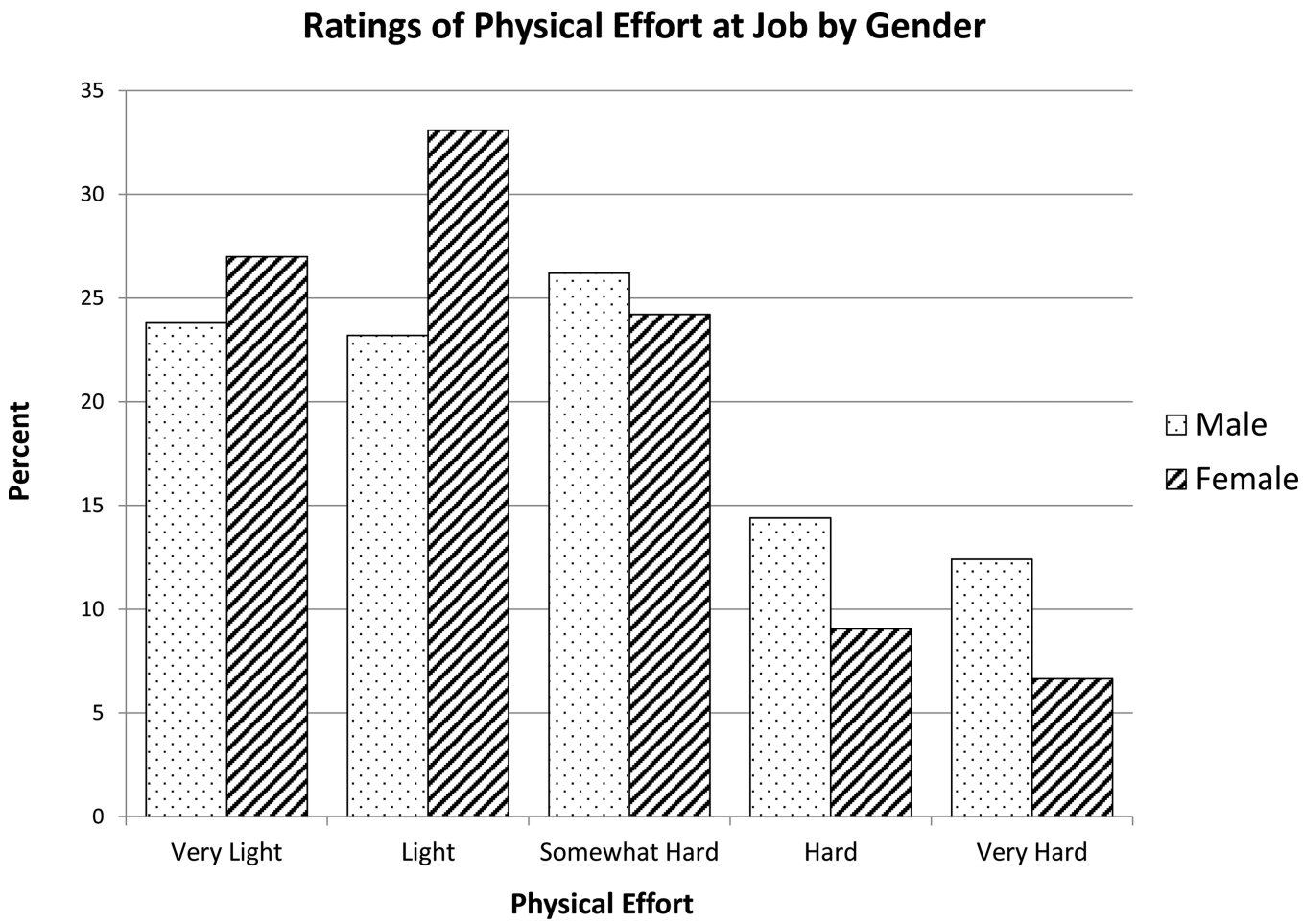

Figure 3.
Ratings of Physical Effort at Job by Gender.

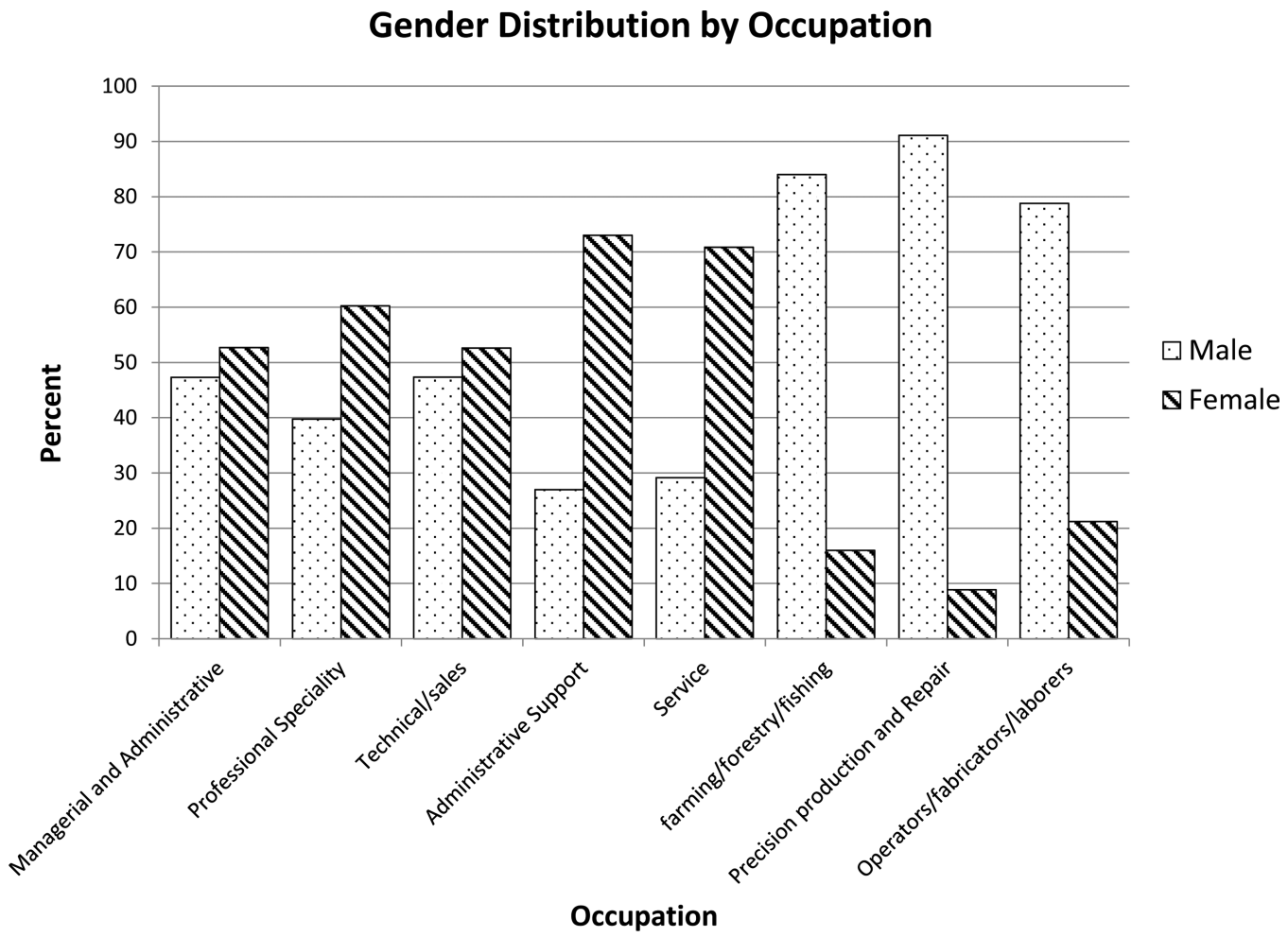

Figure 4.
Gender Distribution by Occupation.

Table I

Interviewee Reports on Back and Arm Pain by Occupational Codes.

	Frequency			% of Study Group			% Reporting "Back Pain"			% Reporting "Pain in Arms"			% Reporting both "Back Pain" and "Pain in Arms"		
Occupation	2002	2006	2010	2002	2006	2010	2002	2006	2010	2002	2006	2010	2002	2006	2010
Managerial and Administrative	249	244	165	17.11	15.91	16.19	26.91	22.13	21.82	24.60	23.36	29.70	14.52	10.66	16.36
Professional Specialty	259	294	175	17.80	19.15	17.17	20.46	19.05	18.29	22.78	20.07	18.29	10.04	8.50	7.43
Technical/sales	221	222	169	15.19	14.48	16.58	22.62	30.63	27.22	25.34	22.52	20.71	13.12	13.96	13.61
Administrative support	181	200	125	12.44	12.94	12.27	27.62	34.00	24.80	32.60	30.00	29.60	13.81	18.50	14.40
Service	190	208	173	13.06	13.58	16.98	34.21	33.00	28.90	31.58	30.77	31.21	21.58	17.79	19.08
Farming/forestry/fishing	23	29	25	1.58	1.88	2.45	34.78	20.69	28.00	21.74	27.59	36.00	17.39	6.90	20.00
Precision production, Craft and Repair	155	167	88	10.65	10.87	8.64	34.84	31.14	30.68	30.32	38.52	31.82	17.42	21.56	21.59
Operators/fabricators/ and laborers	177	172	99	12.16	11.19	9.72	33.33	33.14	29.29	33.90	37.79	36.36	19.77	23.26	21.21
Total	1455*	1537*	1019*				27.90	27.98	25.32	27.99	27.80	27.48	15.34	15.23	15.60

Note

*There were 29 missing values for "back pain" and 30 for "pain in arms" in 2002. There were 26 missing values for "back pain" and 28 for "pain in arms" in 2006. The additional missing values occurred in the "Managerial" classification in 2002 and in the "Service" classification in 2006. There were 35 missing values for both "Back Pain" and "Pain in Arms" in 2010.

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Table II

Risk Factors for "Back Pain" (Frequency Counts and Odds Ratios).

Outcome Measures/Risk Factors				**Back Pain**			**Back Pain**		
Risk Factors. n=number of interviewees*				**Yes Freq. (%)**			**OR (95% CI)**		
Individual Factors	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**
Age							Compared with age 18-24		
18-24	n=127	n=127	n=71	39(30.7%)	35(27.6%)	20(28.2%)			
25-34	n=390	n=365	n=241	114(29.2%)	97(26.6%)	68(28.2%)	0.93(0.60-1.44)	0.96(0.61-1.50)	1.00(0.56-1.81)
35-44	n=376	n=402	n=254	107(28.5%)	122(30.4%)	60(23.6%)	0.90(0.58-1.39)	1.15(0.74-1.79)	0.79(0.44-1.43)
45-54	n=347	n=398	n=253	95(27.4%)	121(30.5%)	63(24.9%)	0.85(0.55-1.33)	1.15(0.74-1.79)	0.85(0.47-1.53)
55-64	n=182	n=212	n=170	44(24.2%)	48(22.6%)	44(25.9%)	0.72(0.43-1.20)	0.77(0.46-1.28)	0.89(0.48-1.66)
>65	n=37	n=49	n=53	10(27.0%)	10(20.4%)	14(26.4%)	0.84(0.37-1.89)	0.67(0.30-1.50)	0.92(0.41-2.04)
Gender							Compared with male		
Male	n=769	n=772	n=503	217(28.2%)	202(26.7%)	126(25.1%)	0.99(0.79-1.24)	1.16(0.95-1.48)	1.08(0.82-1.42)
Female	n=696	n=787	n=540	195(28.0%)	231(29.6%)	143(26.5%)			
Hurt at Work (# times hurt at work last year)							Compared with 0 times.		
0 times	n=1299	n=1370	n=938	326 (25.1%)	343(24.0%)	225(24.0%)			
1 time	n=106	n=112	n=61	50 (47.2%)	54(48.2%)	61(39.3%)	**2.67(1.78-3.98)**	**2.79(1.89-4.12)**	**2.06(1.20-3.51)**
2 times	n=17	n=40	n=20	8 (47.1%)	22(55.0%)	20(45.0%)	**2.64(1.02-6.93)**	**3.66(1.94-6.90)**	**2.60(1.06-6.34)**
=>3 times	n=37	n=14	n=21	24 (64.9%)	14(45.2%)	21(52.4%)	**5.51(2.77-10.95)**	**2.47(1.20-5.06)**	**3.49(1.46-8.32)**
Physical Health (How many days during the past 30 days was your physical health not good?)							Compared with 0-13 days.		
0 - 13 days	n=1482	n=1450	n=958	394(26.6%)	382(26.3%)	223(23.3%)	**2.76(1.85-4.12)**	**3.13(2.03-4.82)**	**4.05(2.53-6.48)**
≥ 14 days	n=104	n=89	n=78	52(50.0%)	47(52.8%)	43(55.1%)			
Mental Health (How many days during the past 30 days was your mental health not good?)							Compared with 0-13 days.		
0 - 13 days	n=1396	n=1415	n=922	359(25.7%)	363(25.7%)	206(22.3%)	**2.41(1.76-3.29)**	**3.20(2.19-4.65)**	**3.73(2.50-5.58)**
≥ 14 days	n=187	n=122	n=112	85(45.5%)	64(52.5%)	58(51.8%)			

Outcome Measures/Risk Factors				Back Pain			Back Pain		
Risk Factors. n=number of interviewees*				**Yes Freq. (%)**			**OR (95% CI)**		
Individual Factors	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**
Health Days (How many days during past 30 days did your poor mental or physical health affect usual activities?)							Compared with 0-13 days.		
0-13 days	n=1521	n=1495	n=955	416(27.4%)	402(26.9%)	244(24.5%)	**2.21(1.35-3.64)**	**4.23(2.31-7.73)**	**3.73(1.99-6.96)**
≥ 14 days	n=66	n=46	n=42	30(45.5%)	28(60.1%)	23(54.8%)			
Physical Factors	2002	2006	2010	2002	2006	2010	2002	2006	2010
Heavy Lifting (Job requires repeated lifting pulling or pushing?)							Yes vs. No		
No	n=794	n=832	n=553	172(21.7%)	192(23.1%)	121(21.9%)	**2.01(1.60-2.54)**	**1.69(1.35-2.11)**	**1.55(1.17-2.05)**
Yes	n=671	n=717	n=489	240(35.8%)	241(33.6%)	148(30.3%)			
Hand Movement (Job requires repetitive, or stressful hand movements or awkward postures)							Yes vs. No		
No	n=714	n=783	n=557	136(19.0%)	167(21.3%)	113(20.3%)	**2.47(1.95-3.14)**	**1.96(1.56-2.46)**	**1.86(1.41-2.47)**
Yes	n=751	n=767	n=485	276(36.6%)	266(34.7%)	156(32.2%)			
Physical Effort (Please rate the overall physical effort at the job you normally do)							Compared with Very Light		
Very Light			n=264			50(19.0%)			
Fairly light			n=295			59(20.0%)			1.07(0.70-1.63)
Somewhat hard			n=262			71(27.1%)			**1.59(1.06-2.40)**
Hard			n=121			42(35.0%)			**2.28(1.40-3.69)**
Very Hard			n=98			46(47.0%)			**3.79(2.29-6.26)**
Psychosocial Factors	2002	2006	2010	2002	2006	2010	2002	2006	2010
Job Satisfaction (How satisfied with job?)							Compared with very satisfied.		
Very satisfied	n=721	n=701	n=461	161(22.3%)	157(22.4%)	104(22.6%)			
Somewhat satisfied	n=580	n=708	n=463	177(30.5%)	215(30.4%)	115(25.0%)	**1.53(1.19-1.96)**	**1.51(1.19-1.92)**	1.13(0.84-1.54)
Not too satisfied	n=113	n=97	n=84	50(44.3%)	46(47.4%)	35(41.7%)	**2.76(1.83-4.16)**	**3.13(2.02-4.84)**	**2.45(1.51-3.99)**
Not at all satisfied	n=48	n=46	n=35	23(47.9%)	15(32.6%)	15(43.0%)	**3.20(1.77-5.79)**	1.67(0.88-3.18)	**2.58(1.27-5.21)**

Outcome Measures/Risk Factors				Back Pain			Back Pain		
Risk Factors. n=number of interviewees*				**Yes Freq. (%)**			**OR (95% CI)**		
Individual Factors	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**
Work Freedom (Freedom to decide how to do my own work)							Compared with not at all true.		
Not at all true	n=66	n=61	n=46	34(51.5%)	20(32.8%)	14(30.4%)			
Not too true Somewhat	n=118	n=144	n=84	31(26.3%)	49(34.0%)	27(32.1%)	**0.34(0.18-0.63)**	1.06(0.56-1.20)	1.08(0.50-2.36)
true	n=453	n=482	n=334	139(30.7%)	144(30.0%)	97(29.0%)	**0.42(0.25-0.70)**	0.87(0.49-1.54)	0.93(0.48-1.83)
Very true	n=825	n=850	n=578	207(25.1%)	218(25.7%)	131(22.7%)	**0.32(0.19-0.52)**	0.71(0.41-1.23)	0.67(0.35-1.29)
Supervisor Support							Compared with very true.		
Very true	n=524	n=539	n=379	126(24.1%)	140(26.0%)	79(20.1%)			
Somewhat true	n=614	n=641	n=422	168(27.4%)	164(25.6%)	107(25.4%)	1.19(0.91-1.56)	0.98(0.75-1.273)	1.29(0.93-1.80)
Not too true	n=196	n=220	n=163	61(63.4%)	83(37.7%)	54(33.1%)	1.43(0.99-2.05)	**1.73(1.24-2.411)**	**1.88(1.25-2.83)**
Not at all true	n=102	n=91	n=56	49(48.1%)	29(31.9%)	25(44.6%)	**2.92(1.89-4.52)**	1.33(0.82-2.157)	**3.06(1.71-5.48)**
Work Time (Enough time to get job done.)							Compared with very true.		
Very true	n=607	n=594	n=405	161 (26.5%)	158(26.6%)	91(22.5%)			
Somewhat true	n=580	n=671	n=459	160 (27.6%)	176(26.2%)	127(27.7%)	1.06(0.82-1.40)	0.98(0.76-1.26)	1.32(0.97-1.80)
Not too true	n=169	n=193	n=121	51 (30.2%)	64(33.2%)	34(28.1%)	1.20(0.82-1.74)	1.37(0.96-1.94)	1.35(0.85-2.14)
Not at all true	n=106	n=99	n=56	39 (36.8%)	32(40.5%)	17(30.4%)	**1.61(1.05-2.49)**	**1.88(1.16-3.05)**	1.50(0.81-2.78)
Work Fast (Job requires I work fast.)							Compared with strongly disagree.		
Strongly Disagree	n=48	n=57	n=29	14(29.2%)	17(29.8%)	5(17.2%)			
Disagree	n=477	n=444	n=300	128(26.8%)	109(24.6%)	59(21.9%)	0.89(0.46-1.71)	0.77(0.42-1.41)	1.18(0.43-3.21)
Agree	n=619	n=713	n=485	160(25.9%)	203(28.4%)	134(27.6%)	0.85(0.44-1.62)	0.94(0.52-1.69)	1.83(0.69-4.90)
Strongly Agree	n=317	n=332	n=226	108(34.1%)	104(31.3%)	71(31.4%)	1.26(0.65-2.44)	1.07(0.58-1.98)	2.20(0.81-6.00)
Work hours (# hours(h) worked last week)							Compared with < 40h		
≤40h	n=746	n=837	n=583	209(28.0%)	221(26.1%)	158(27.1%)			
41-50h	n=402	n=377	n=261	124(30.9%)	116(30.8%)	57(21.8%)	1.15(0.88-1.49)	1.24(0.95-1.62)	0.75(0.53-1.06)

Outcome Measures/Risk Factors				Back Pain			Back Pain		
Risk Factors. n=number of interviewees*				**Yes Freq. (%)**			**OR (95% CI)**		
Individual Factors	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**
51-60h	n=188	n=208	n=129	35(18.6%)	58(27.9%)	34(26.4%)	**0.59(0.39-0.88)**	1.08(0.77-1.51)	0.96(0.63-1.48)
61-70h	n=69	n=60	n=40	22(31.9%)	14(23.3%)	11(27.5%)	1.20(0.71-2.05)	0.85(0.46-1.57)	1.02(0.50-2.09)
>71h	n=56	n=71	n=30	20(35.7%)	24(33.8%)	9(30.0%)	1.43(0.81-2.52)	1.42(0.85-2.38)	1.15(0.52-2.57)
Must Work (Mandatory to work extra hours.)							Yes vs. No		
No	n=1041	n=1101	n=724	262(25.2%)	288(26.2%)	181(25.0%)			
Yes	n=411	n=429	n=303	146(35.5%)	140(32.6%)	8 5 (28. 1%)	**1.64(1.28-2.10)**	**1.37(1.07-1.74)**	1.17(0.87-1.58)
Safety climate							Compared with strongly agree.		
Strongly agree	n=504	n= 822	n=527	126(25.0%)	213(25.9%)	122(23.2%)			
Agree	n=713	n=578	n=414	19 (27.2%)	161(27.9%)	106(25.6%)	1.12(0.86-1.46)	1.10(0.87-1.40)	1.14(0.85-1.54)
Disagree	n=179	n=89	n=58	68(38.0%)	32(36.0%)	20(34.5%)	**1.84(1.28-2.64)**	**1.61(1.01-2.54)**	1.75(0.98-3.11)
Strongly disagree	n=65	n=51	n=41	21(32.3%)	24(47.1%)	21(51.2%)	1.43(0.82-2.50)	**2.54(1.44-4.50)**	**3.49(1.83-6.64)**
Work Stress (How often is work stressful?)							Compared with never.		
Never	n=88	n=80	n=59	20(22.7%)	15(18.8%)	12(20.3%)			
Hardly ever	n=255	n=255	n=178	51(20.0%)	50(19.6%)	32(18.0%)	0.85(0.47-1.53)	1.06(0.56-2.01)	0.86(0.41-1.80)
Sometimes	n=622	n=694	n=437	151(24.3%	174(25.1%)	104(23.8%)	1.09(0.64-0.85)	1.45(0.81-2.61)	1.22(0.63-2.39)
Often	n=350	n=347	n=266	121(34.6%)	121(34.9%)	78(29.3%)	**1.80(1.04-3.10)**	**2.32(1.27-4.24)**	1.63(0.82-3.23)
Always	n=148	n=174	n=103	68(46.0%)	73(42.0%)	43(41.8%)	**2.89(1.60-5.24)**	**3.13(1.66-5.92)**	**2.81(1.33-5.91)**
Work Schedule							Compared with day shift.		
Day Shift	n=1078	n=1168	n=781	297(27.6%)	310(26.5%)	189(24.2%)			
Afternoon Shift	n=53	n=55	n=49	18(34.0%)	19(34.6%)	13(26.5%)	1.35(0.75-2.43)	1.46(0.826-2.585)	1.13(0.59-2.18)
Night Shift	n=94	n=92	n=54	22(23.4%)	30(32.6%)	14(25.9%)	0.80(0.49-1.32)	1.34(0.850-2.111)	1.10(0.58-2.06)
Split Shift	n=38	n=29	n=28	11(29.0%)	12(41.4%)	8(28.6%)	1.07(0.53-2.19)	1.95(0.923-4.139)	1.25(0.54-2.89)
Irreg./on call	n=124	n=129	n=83	38(30.7%)	36(27.9%)	23(27.7%)	1.16(0.78-1.74)	1.07(0.714-1.608)	1.20(0.72-1.20)

Outcome Measures/Risk Factors				Back Pain			Back Pain		
Risk Factors. n=number of interviewees*				**Yes Freq. (%)**			**OR (95% CI)**		
Individual Factors	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**
Rotating Shift	n=73	n=74	n=44	23(31.5%)	25(33.8%)	22(50%)	1.21(0.73-2.02)	1.43(0.857-2.326)	**3.13(1.70-5.78)**
Dichotomized Variables	2002	2006	2010	2002	2006	2010	2002	2006	2010
Job Satisfaction (Are you satisfied with your job?)							No vs. Yes		
Yes	n=1301	n=1409	n=924	338(26.0%)	372(26.4%)	219(23.7%)	**2.36(1.69-3.30)**	**2.08(1.46-2.95)**	**2.33(1.57-3.46)**
No	n=161	n=143	n=119	73(45.3%)	61(43.0%)	50(42.2%)			
Safety Climate (Are safety conditions good at work?)							Yes vs. No		
No	n=244	n=140	n=99	89(36.5%)	56(40.0%)	41(41.4%)	**0.62(0.47-0.830)**	**0.55(0.38-0.78)**	**0.45(0.30-0.69)**
Yes	n=1217	n=1400	n=941	320(26.3%)	374(26.7%)	228(24.2%)			
Work Stress (How often is work stressful?)							Yes vs. No		
No 3,4,5	n=965	n=1029	n=674	222(23.0%	239(23.2%)	148(22.0%)	**2.05(1.62-2.59)**	**1.96(1.56-2.47)**	**1.73(1.31-2.30)**
Yes 1,2	n=498	n=521	n=369	189(38.0%)	194(37.2%)	121(32.8%)			
Work Fast (Does the job require that I work fast?)							Yes vs. No		
No	n=525	n=501	n=329	142(27.1%)	126(25.2%)	64(19.5%)	1.08(0.85-1.37)	1.24(0.97-1.58)	**1.67(1.22-2.30)**
Yes	n=936	n=1045	n=711	268(28.6%)	307(29.4%)	205(28.8%)			
Work Time (Is there enough time to get the job done?)							Yes vs. No		
No	n=275	n=272	n=177	90(32.7%)	96(35.3%)	51(28.8%)	0.76(0.57-1.04)	**0.66(0.50-0.87)**	0.83(0.58-1.20)
Yes	n=1187	n=1265	n=864	321(27.0%)	334(26.4%	218(25.2%)			
Risk Factor Combinations	2002	2006	2010	2002	2006	2010	2002	2006	2010
Heavy Lifting and Work Stress 3,4,5							Compared with No-No		
No-No	n=517	n=554	n=354	91(17.6%)	108(19.5%)	63(17.8%)			
No-Yes	n=277	n=278	n=199	81(29.4%)	84(30.2%)	58(29.2%)	**1.94(1.37-2.73)**	**1.79(1.28-2.49)**	**1.90(1.26-2.86)**

Outcome Measures/Risk Factors				Back Pain			Back Pain		
Risk Factors. n=number of interviewees*				Yes Freq. (%)			OR (95% CI)		
Individual Factors	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**
Yes-No	n=448	n=474	n=319	131(29.4%)	131(27.6%)	85(26.7%)	**1.94(1.43-2.62)**	**1.58(1.18-2.11)**	**1.68(1.16-2.43)**
Yes-Yes	n=221	n=242	n=170	108(48.9%)	110(45.5%)	63(37.1%	**4.47(3.16-6.33)**	**3.44(2.48-4.78)**	**2.72(1.80-4.11)**
Interaction							1.20(0.74-1.93)	1.22(0.77-1.94)	0.85 (0.48-1.51)
Heavy Lifting and Work Fast							Compared with No-No		
No-No	n=305	n=284	n=178	68(22.3%)	61(21.5%)	32(18.0%)			
No-Yes	n=488	n=544	n=372	104(21.3%)	131(24.0%)	89(23.9%)	0.94(0.67-1.33)	1.16(0.82-1.64)	1.44(0.91-2.25)
Yes-No	n=220	n=217	n=151	74(33.6%)	65(29.7%)	32(21.2%)	**1.77(1.20-2.61)**	**1.56(1.04-2.35)**	1.23(0.71-2.12)
Yes-Yes	n=448	n=500	n=338	164(36.6%)	176(35.2%)	116(43.3%)	**2.01(1.45-2.80)**	**1.99(1.42-2.78)**	**2.36(1.53-3.72)**
Interaction							1.21(0.74-1.96)	1.10(0.67-1.78)	1.35(0.72-2.56)
Heavy Lifting and Work Time							Compared with No-Yes		
No-Yes	n=636	n=671	n=453	135(21.2%)	142(21.2%)	96(21.2%)			
No-No	n=156	n=153	n=100	37(23.7%)	49(32.0%	25(25.0%)	1.15 (0.76-1.75)	**1.76(1.19-2.58)**	1.24(0.75-2.06)
Yes-Yes	n=551	n=594	n=410	186(33.8%)	192(32.3%)	122(29.8%)	**1.89(1.46-2.45)**	**2.47(1.63-3.73)**	**1.58(1.16-2.15)**
Yes-No	n=119	n=118	n=77	53(44.5%)	47(39.8%)	26(33.8%)	**2.98(1.98-4.48)**	**1.80(1.38-2.29)**	**1.90(1.12-3.20)**
Interaction							1.37(0.78-2.08)	0.79(0.45-1.38)	0.67(0.33-1.38)
Hand Movement and Work Stress 3,4,5							Compared with No-No		
No-No	n=491	n=544	n=366	80(16.3%)	106(19.5%)	58(15.9%)			
No-Yes	n=223	n=238	n=191	56(25.1%)	61(25.6%)	55(28.8%)	**1.72(1.17-2.53)**	1.42(0.93-2.01)	**2.15(1.41-3.27)**
Yes-No	n=474	n=485	n=307	142(30.0%	133(27.4%)	90(29.3%)	**2.20(1.61-3.00)**	**1.56(1.17-2.09)**	**2.20(1.52-3.20)**
Yes-Yes	n=275	n=282	n=178	133(48.4)	133(47.2%)	66(37.1%)	**4.81(3.44-6.74)**	**3.69(2.69-5.09)**	**3.13(2.07-4.73)**
Interaction							1.37(0.77-2.08)	**1.66(1.03-2.66)**	0.97(0.47-2.00)
Hand Movement and Work Fast							Compared with No-No		
No-No	n=301	n=285	n=193	59(19.6%)	60(21.1%)	31(16.1%)			
No-Yes	n=412	n=404	n=361	77(18.7%)	107(21.7%)	82(22.7%)	0.94(0.65-1.38)	1.04(0.73-1.48)	1.53(0.97-2.42)

Outcome Measures/Risk Factors				Back Pain			Back Pain		
Risk Factors. n=number of interviewees*				Yes Freq. (%)			OR (95% CI)		
Individual Factors	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**
Yes-No	n=224	n=216	n=136	83(37.0%)	66(30.1%)	33(24.3%)	**2.41(1.63-3.58)**	**1.65(1.10-2.48)**	1.67(0.97-2.90)
Yes-Yes	n=524	n=551	n-349	191(36.5%)	200(36.0%)	123(35.2%)	**2.35(1.68-3.29)**	**2.14(1.53-2.98)**	**2.84(1.83-4.43)**
Interaction							1.03 (0.63-1.67)	1.25(0.77-2.04)	1.11(0.58-2.10)
Hand Movement and Work Time							Compared with No-Yes		
No-Yes	n=586	n=652	n=474	110(18.8%)	138(21.2%)	97(20.5%)			
No-No	n=126	n=123	n=82	26(20.6%)	27(22.0%)	16(19.5%)	1.13(0.70-1.82)	1.04(0.66-1.67)	0.94(0.52-1.70)
Yes-Yes	n=601	n=667	n=389	211(35.1%)	196(32.0%)	121(31.1%)	**2.34(1.79-3.06)**	**3.21(2.21-4.66)**	**1.76(1.29-2.39)**
Yes-No	n=149	n=69	n=95	64(43.0%)	69(46.3%)	35(36.8%)	**2.35(1.68-3.29)**	**1.75(1.36-2.26)**	**2.27(1.41-3.64)**
Interaction							1.24(0.68-2.26)	1.75(0.97-3.17)	1.37(0.65-2.91)
Physical Effort 3,4,5 and Work Stress 3,4,5							Compared with No-No		
No-No			n=365			58(15.9%)			
No-Yes			n=194			51(26.3%)			**1.89(1.23-2.89)**
Yes-No			n=306			89(29.1%)			**2.17(1.49-3.15)**
Yes-Yes			n=175			70(40.0%)			**3.53(2.34-5.33)**
Interaction									0.86(0.48-1.53)
Physical Effort 3,4,5 and Work Fast							Compared with No-No		
No-No			n=178			32(18.0%)			
No-Yes			n=372			89(23.9%)			1.45(0.92-2.31)
Yes-No			n=151			32(21.2%)			1.72(0.99-2.97)
Yes-Yes			n=338			116(34.3%)			**3.05(1.95-4.78)**
Interaction									1.22 (0.64-2.33)
Physical Effort 3,4,5 and Work Time							Compared with No-Yes		
No-Yes			n=474			97(20.5%)			
No-No			n=82			16(19.5%)			1.24(0.75-2.06)

Outcome Measures/Risk Factors				Back Pain			Back Pain		
Risk Factors. n=number of interviewees*				Yes Freq. (%)			OR (95% CI)		
Individual Factors	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**
Yes-Yes			n=389			121(31.1%)			**1.90(1.12-3.20)**
Yes-No			n=95			35(36.8%)			**1.58(1.16-2.15)**
Interaction									0.97(0.47-2.00)

*Number of interviewees with usable data.

Table III

Risk Factors for "Pain in Arms" (Frequency Counts and Odds Ratios)

Outcome Measures/Risk Factors				**Pain in Arms**			**Pain in Arms**		
n=number of interviewees *				**Yes Freq (%)**			**OR (95% CI)**		
Individual Factors	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**
Age							Compared with age 18-24		
18-24	n=127	n=127	n=71	29(22.8%)	33(26.0%)	13(18.3%)			
25-34	n=390	n=365	n=241	97(24.9%)	76 (20.7%)	57(23.7%)	1.12(0.70-1.80)	0.75(0.47-1.20)	1.38(0.71-2.70)
35-44	n=376	n=402	n=254	107(28.5%)	118(29.4%)	70(23.6%)	1.34(0.84-2.15)	1.18(0.75-1.86)	1.70(0.88-3.29)
45-54	n=346	n=397	n=253	111(32.0%)	124(31.2%)	63(27.6%)	1.60(0.99-2.56)	1.29(0.83-2.21)	**1.99(1.03-3.84)**
55-64	n=182	n=212	n=170	57(31.3%)	67(31.6%)	57(33.5%)	1.54(0.92-2.59)	1.32(0.81-2.15)	**2.25(1.14-4.45)**
> 65	n=37	n=49	n=53	10(27.0%)	13(23.5%)	13(24.5%)	1.25(0.54-2.89)	1.25(0.54-2.89)	1.45(0.61-3.45)
Gender							Compared with male		
Male	n=769	n=771	n=503	213(27.7%)	199(26.7%)	122(24.3%)			
Female	n=695	n=781	n=540	201(28.9%)	232(29.6%)	166(30.7%)	1.06(0.85-1.33)	1.22(0.97-1.52)	**1.39(1.05-1.82)**
Hurt at Work (# times hurt at work last year)							Compared with 0 times.		
0 times	n=1299	n=1369	n=938	324(24.9%)	336(24.5%)	238(25.4%)			
1 time	n=106	n=112	n=61	56(52.8%)	56(50.0%)	26(42.6%)	**3.37(2.25-5.03)**	**3.07(2.08-4.45)**	**2.19(1.29-3.71)**
2 times	n=17	n=40	n=20	10(58.8%)	24(60.0%)	8(40.0%)	**4.30(1.62-11.37)**	**4.61(2.42-8.79)**	1.96(0.79-4.86)
=> 3 times	n=37	n=31	n=21	20(54.0%)	15(48.4%)	13(61.2%)	**3.54(1.83-6.83)**	**2.88(1.41-5.89)**	**4.78(1.96-11.67)**
Physical Health (How many days during the past 30 days was your physical health not good?)							Compared with 0-13 days.		
0 - 13 days	n=1482	n=1449	n=958	399(26.9%)	382(26.4%)	233(24.3%)			
≥ 14 days	n=103	n=89	n=78	48(46.6%)	47(52.8%)	51(65.4%)	**2.37(1.58-3.55)**	**3.13(2.03-4.82**	**5.88(3.60-9.59)**
Mental Health (How many days during the past 30 days was your mental health not good?)							Compared with 0-13 days.		
0 - 13 days	n=1395	n=1414	n=922	366(26.2%)	367(26.0%)	227(24.6%)			
≥ 14 days	n=187	n=122	n=112	80(42.8%)	61(50.0%)	56(50.0%)	**2.10(1.54-2.88)**	**2.85(1.96-4.15)**	**3.06(2.05-4.57)**

Outcome Measures/Risk Factors				Pain in Arms			Pain in Arms		
n=number of interviewees*				Yes Freq (%)			OR (95% CI)		
Individual Factors	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**
Health Days (How many days during past 30 days did your poor mental or physical health affect usual activities?)							Compared with 0-13 days.		
0 - 13 days	n=1520	n=1494	n=955	414(27.2%)	406(27.2%)	256(25.7%)			
≥ 14 days	n=66	n=46	n=42	34(51.5%)	23(60.1%)	28(66.7%)	**2.84(1.73-4.66)**	**2.68(1.49-4.83)**	**5.77(2.99-11.14)**
Physical Factors	2002	2006	2010	2002	2006	2010	2002	2006	2010
Heavy Lifting (Job requires repeated lifting pulling or pushing?)							Yes vs. No		
No	n=794	n=832	n=553	285(35.9%)	183(22.0%)	127(23.0%)			
Yes	n=671	n=716	n=489	229(34.1%)	248(33.6%)	161(34.6%)	**1.70(1.35-2.14)**	**1.88(1.50-2.35)**	**1.65(1.25-2.16)**
Hand Movement (Job requires repetitive, or stressful hand movements or awkward postures)							Yes vs. No		
No	n=714	n=783	n=557	138(13.9%)	132(16.9%)	101(18.1%)	**2.42(1.91-3.07)**	**3.16(2.49-4.00)**	**2.83(2.14-3.76)**
Yes	n=751	n=766	n=485	276(36.8%)	299(39.0%)	187(38.6%)			
Physical Effort (Please rate the overall physical effort at the job you normally do)							Compared with very light		
Very Light			n=264			53(20.1%)			
Fairly light			n=295			67(22.7%)			1.17(0.78-1.76)
Somewhat hard			n=262			64(24.4%)			1.29(0.85-1.94)
Hard			n=121			46(38.0%)			**2.44(1.52-3.93)**
Very Hard			n=98			57(58.2%)			**5.54(3.35-9.14)**
Psychosocial Factors	2002	2006	2010	2002	2006	2010	2002	2006	2010
Job Satisfaction (How satisfied with job?)							Compared with very satisfied.		
Very satisfied	n=721	n=700	n=461	16 22.3%)	161(23.0%)	116(25.2%)			
Somewhat satisfied	n=580	n=708	n=463	177(30.5%)	216((30.5%)	123(26.6%)	**1.53(1.19-1.96)**	**1.47(1.16-1.86)**	1.08(0.80-1.45)
Not too satisfied	n=113	n=197	n=84	5(44.3%)	36(37.1%)	35(41.7%)	**2.76(1.83-4.16)**	**1.98(1.26-3.09)**	**2.13(1.31-3.44)**
Not at all satisfied	n=48	n=46	n=35	23(47.9%)	18(39.1%)	14(40.0%)	**3.20(1.77-5.79)**	**2.15(1.16-3.99)**	1.98(0.98-4.03)

Outcome Measures/Risk Factors				Pain in Arms			Pain in Arms		
n=number of interviewees*				Yes Freq (%)			OR (95% CI)		
Individual Factors	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**
Work Freedom (Freedom to decide how to do my own work)							Compared with not at all true.		
Not at all true	n=66	n=61	n=46	27(40.9%)	25(41.0%)	19(41.3%)			
Not too true	n=118	n=144	n=84	40(33.9%)	48(33.3%)	28(33.3%)	0.74(0.40-1.14)	0.72(0.39-1.33)	0.71(0.34-1.49)
Somewhat true	n=453	n=482	n=334	137(30.2%)	145(30.1%)	90(27.0%)	0.63(0.37-1.07)	0.62(0.36-1.07)	**0.52(0.28-0.99)**
Very true	n=825	n=849	n=578	209(25.3%)	212(25.0%)	151(26.1%)	**0.49(0.29-0.82)**	**0.48(0.28-0.82)**	**0.50(0.27-0.93)**
Supervisor Support							Compared with very true.		
Very true	n=523	n=539	n=379	136(261%)	114(21.2%)	92(24.3%)			
Somewhat true	n=614	n=641	n=422	156(25.4%)	182(28.4%)	102(24.2%)	0.97(0.74-1.27)	**1.48(1.13-1.93)**	0.99(0.72-1.37)
Not too true	n=196	n=220	n=163	67(34.2%)	88(40.0%)	68(41.3%)	**1.48(1.04-2.11)**	**2.49(1.77-3.49)**	**2.23(1.51-3.30)**
Not at all true	n=102	n=91	n=56	45(44.1%)	33(36.3%)	22(39.3%)	**2.25(1.45-3.48)**	**2.12(1.32-3.41)**	**2.02(1.12-3.63)**
Work Time (Enough time to get job done.)							Compared with very true.		
Very true	n=607	n=593	n=405	150(24.7%)	144(24.3%)	99(24.4%)			
Somewhat true	n=580	n=671	n=459	167(28.8%)	182(27.1%)	131(28.5%)	1.23(0.95-1.59)	1.16(0.90-1.50)	1.23(0.91-1.67)
Not too true	n=169	n=193	n=121	50(39.6%)	72(37.3%)	39(32.3%)	1.28(0.88-1.87)	**1.86(1.31-2.63)**	1.47(0.94-2.29)
Not at all true	n=105	n=79	n=56	46(43.8%)	30(38.0%)	19(33.9%)	**2.38(1.55-3.64)**	**1.91(1.17-3.12)**	1.59(0.87-2.89)
Work Fast (Job requires I work fast.)							Compared with strongly disagree.		
Strongly Disagree	n=48	n=57	n=29	11(22.9%)	19(33.3%)	7(24.1%)			
Disagree	n=477	n=443	n=300	127(26.6%)	109(24.6%)	64(21.3%)	1.24(0.61-2.50)	0.65(0.36-1.18)	0.85(0.35-2.09)
Agree	n=619	n=713	n=485	180(29.1%)	190(26.7%)	142(29.3%)	1.38(0.69-2.76)	0.73(0.41-1.29)	1.30(0.54-3.11)
Strongly Agree	n=317	n=332	n=226	94(29.7%)	113(34.0%)	75(33.2%)	1.42(0.69-2.90)	1.03(0.57-1.87)	1.56(0.64-3.82)
Work hours (# hours(h) worked last week)							Compared with < 40h		
≤40h	n=746	n=837	n=583	267(29.6%)	225(26.8%)	152(26.0%)			
41-50h	n=402	n=377	n=261	111(27.6%)	109(28.9%)	75(28.7%)	0.91(0.69-1.19)	1.11(0.84-1.45)	1.14(0.83-1.58)

Outcome Measures/Risk Factors				Pain in Arms			Pain in Arms		
n=number of interviewees*				Yes Freq (%)			OR (95% CI)		
Individual Factors	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**
51-60h	n=188	n=207	n=129	37(19.7%)	61(29.5%)	32(24.8%)	**0.58(0.39-0.86)**	1.14(0.81-1.59)	0.94(0.60-1.45)
61-70h	n=69	n=60	n=40	21(30.4%)	15(25.0%)	17(42.5%)	1.04(0.61-1.78)	0.91(0.50-1.66)	**2.10(1.09-4.01)**
>71h	n=55	n=71	n=30	23(41.1%)	21(29.6%)	12(40.0%)	1.71(0.98-2.98)	1.14 (0.67-1.95)	1.89(0.89-4.02)
Must Work (Mandatory to work extra hours.)							yes vs. no		
No	n=1041	n=1100	n=724	267(25.7%)	289(26.2%)	200(27.6%)			
Yes	n=411	n=429	n=303	143(34.8%)	138(32.2%)	86(28.4%)	**1.55(1.21-1.99)**	**1.33(1.04-1.70)**	1.04(0.77-1.40)
Safety climate							Compared with strongly agree.		
Strongly agree	n=504	n= 821	n=527	136(27.0%)	197(24.0%)	125(23.7%)			
Agree	n=712	n=578	n=414	181(25.4%)	172(29.8%)	112(27.1%)	0.92(0.71-1.20)	1.34(1.06-1.71)	1.19(0.89-1.60)
Disagree	n=179	n=89	n=58	68(38.0%)	35(39.3%)	26(44.8%)	**1.66(1.16-2.38)**	**2.05(1.30-3.24)**	**2.61(1.50-4.55)**
Strongly disagree	n=65	n=51	n=41	26(40.0%)	25(49.0%)	25(70.0%)	**1.80(1.06-3.08)**	**3.05(1.72-5.39)**	**5.03(2.60-9.71)**
Work Stress (How often is work stressful?)							Compared with never.		
Never	n=88	n=80	n=59	22(25.0%)	12(15.0%)	10(17.0%)			
Hardly ever	n=255	n=254	n=178	55(21.6%)	53(20.1%)	30(16.9%)	0.83(0.47-1.46)	1.49(0.75-2.96)	0.99(0.45-2.18)
Sometimes	n=622	n=694	n=437	143(23.0%	176(25.4%)	116(26.5%)	0.90(0.54-1.51)	**1.93(1.02-3.64)**	1.77(0.87-3.61)
Often	n=350	n=347	n=266	125(35.7%)	110(31.7%)	81(30.5%)	1.67(0.98-2.83)	**2.63(1.37-5.06)**	**2.15(1.04-4.45)**
Always	n=148	n=174	n=103	68 (46.0%)	80(46.0%)	51(49.5%)	**2.55(1.43-4.56)**	**4.82(2.44-9.54)**	**4.81(2.20-10.51)**
Work Schedule							Compared with day shift.		
Day Shift	n=1078	n=1167	n=781	304(28.2%)	320(27.4%)	206(26.2%)			
Afternoon Shift	n=53	n=55	n=49	14(26.4%)	20(36.4%)	16(33.3%)	0.91(0.489-1.705)	1.51(0.86-2.66)	1.35(0.73-2.51)
Night Shift	n=94	n=92	n=54	24(25.5%)	27(29.4%)	19(35.2%)	0.87(0.538-1.412)	1.10(0.69-1.75)	1.52(0.85-2.71)
Split Shift	n=38	n=29	n=28	11(29.0%)	11(38.0%)	7(25.0%)	1.04(0.508-2.115)	1.62(0.76-3.46)	0.93(0.39-2.22)
Irreg./on call	n=124	n=129	n=83	39(31.5%)	37(28.7%)	25(30.1%)	1.17(0.781-1.743)	1.07(0.71-1.59)	1.20(0.73-1.97)
Rotating Shift	n=73	n=74	n=44	19(26.0%)	15(20.3%)	15(34.1%)	0.99(0.522-1.534)	0.67(0.38-1.20)	1.44 (0.76-2.75)

Outcome Measures/Risk Factors				Pain in Arms			Pain in Arms		
n=number of interviewees*				Yes Freq (%)			OR (95% CI)		
Individual Factors	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**
Dichotomized Variables	2002	2006	2010	2002	2006	2010	2002	2006	2010
Job Satisfaction (Are you satisfied with your job?)							Yes vs. No		
Yes	n=1301	n=1408	n=924	341(26.2%)	377(26.8%)	239(25.9%)			
No	n=161	n=143	n=119	72(44.7%)	54(37.8%)	49(41.2%)	**2.28(1.63-3.18)**	**1.66(1.16-2.37)**	**2.01(1.35-2.98)**
Safety Climate (Are safety conditions good at work?)							Yes vs. No		
No	n=244	n=140	n=99	94(38.5%)	60(40.0%)	51(51.5%)			
Yes	n=1217	n=1399	n=941	320(26.3%)	369(26.2%)	237(25.2%)	**0.56(0.42-0.75)**	**0.48(0.34-0.68)**	**0.32(0.21-0.48)**
Work Stress (How often is work stressful?)							Yes vs. No		
No 3,4,5	n=965	n=1028	n=674	220(22.8%)	241(23.4%)	156(23.2%)			
Yes 1,2	n=498	n=521	n=369	193(38.8%)	290(36.5%)	132(35.8%)	**2.14(1.69-2.71)**	**1.88(1.49-2.36)**	**1.85(1.40-2.44)**
Work Fast (Does the job require that I work fast?)							Yes vs. No		
No	n=525	n=501	n=329	139(26.5%)	128(25.6%)	71(21.6%)			
Yes	n=936	n=1045	n=711	274(29.3%)	307(29.0%)	217(30.5%)	1.15(0.90-1.46)	1.19(0.94-1.52)	**1.60(1.17-2.17)**
Work Time (Is there enough time to get the job done?)							Yes vs. No		
No	n=275	n=272	n=177	96(34.0%)	102(37.5%)	58(32.8%)			
Yes	n=1187	n=1264	n=864	317(26.7%)	326(25.8%)	230(26.6%)	**0.68(0.51-0.89)**	**0.58(0.44-0.76)**	0.74(0.53-1.05)
Risk Factor Combinations	2002	2006	2010	2002	2006	2010	2002	2006	2010
Heavy Lifting and Work Stress 3,4,5							Compared with No-No		
No-No									
No-Yes	n=517	n=554	n=354	94(18.2%)	110(19.9%)	63(17.8%)	**2.20(1.57-3.07)**	**1.44(1.02-2.02)**	**1.77(1.18-2.65)**
Yes-No	n=277	n=278	n=199	91(32.0%)	73(26.3%)	58(29.2%)	**1.76(1.30-2.38)**	**1.55(1.16-2.07)**	**1.60(1.12-2.30)**

Outcome Measures/Risk Factors				Pain in Arms			Pain in Arms		
n=number of interviewees*				Yes Freq (%)			OR (95% CI)		
Individual Factors	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**
Yes-Yes	n=448	n=473	n=319	126(28.1%)	131(27.7%)	85(26.7%)	**3.85(2.77-5.44)**	**3.78(2.75-5.24)**	**3.17(2.12-4.74)**
Interaction	n=221	n=242	n=170	102(46.2%)	117(48.4%)	63(37.1%)	1.00(0.62-1.60)	**1.70(1.07-2.72)**	1.12(0.64-1.95)
Heavy Lifting and Work Fast							Compared with No-No		
No-No									
No-Yes	n=305	n=284	n=178	64(21.0%)	61(21.3%)	38(21.4%)	1.24(0.88-1.74)	1.06(0.75-1.50)	1.16(0.75-1.78)
Yes-No	n=488	n=544	n=372	121(24.8%)	122(22.4%)	89(23.9%)	**1.94(1.31-2.87)**	**1.69(1.10-2.46)**	1.03(0.61-1.75)
Yes-Yes	n=220	n=216	n=151	75(34.1%)	67(31.0%)	33(21.9%)	**1.94(1.39-2.28)**	**2.07(1.48-2.91)**	**2.25(1.48-3.42)**
Interaction	n=448	n=500	n=338	153(34.2%)	181(36.2%)	128(37.9%)	0.81(0.50-1.32)	1.19(0.73-1.94)	**1.88(1.01-3.49)**
Heavy Lifting and Work Time							Compared with No-Yes		
No-Yes									
No-No	n=636	n=671	n=372	137(21.5%)	137(20.4%)	89(23.4%)	1.63(1.11-2.41)	**1.52(1.02-2.27)**	1.22(0.74-2.02)
Yes-Yes	n=155	n=153	n=178	48(31.0%)	43(28.1%	38(21.4%)	**1.89(1.46-2.45)**	**1.82(1.41-2.35)**	**1.60(1.18-2.17)**
Yes-No	n=551	n=593	n=338	180(32.7%)	189(31.9%)	128(37.9%)	**2.98(1.98-4.48)**	**3.90(2.60-5.85)**	**2.48(3.50-7.98)**
Interaction	n=119	n=118	n=151	48(40.3%)	59(50.0%)	33(21.9%)	0.85(0.48-1.49)	1.40(0.80-2.47)	0.97(0.55-1.74)
Hand Movement and Work Stress 3,4,5							Compared with No-No		
No-No									
No-Yes	n=491	n=544	n=366	81(16.5%)	83(15.3%)	54(15.0%)	**1.73(1.18-2.55)**	1.44(0.97-2.13)	**1.89(1.22-2.92)**
Yes-No	n=223	n=238	n=191	57(25.6%)	49(20.6%)	47(24.6%)	**2.10(1.54-2.86)**	**2.69(1.99-3.64)**	**2.88(1.98-4.18)**
Yes-Yes	n=474	n=484	n=307	139(29.3%	158(32.6%)	102(33.2%)	**4.94(3.53-6.91)**	**5.55(3.99-7.73)**	**5.28(2.07-4.73)**
Interaction	n=275	n=282	n=178	136(49.5)	141(50.0%)	85(47.8%)	1.36(0.83-2.23)	1.43(0.87-2.66)	0.66(0.37-1.17)
Hand Movement and Work Fast							Compared with No-No		
No-No									
No-Yes	n=301	n=285	n=193	56(18.6%)	49(17.2%)	28(14.5%)	1.08(0.74-1.58)	0.97(0.66-1.43)	1.49(0.93-2.40)
Yes-No	n=412	n=494	n=361	82(19.9%)	83(16.8%)	73(20.2%)	**2.57(1.72-3.82)**	**2.80(1.85-4.23)**	**2.73(1.59-4.67)**

Outcome Measures/Risk Factors				Pain in Arms			Pain in Arms		
n=number of interviewees*				Yes Freq (%)			OR (95% CI)		
Individual Factors	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**
Yes-Yes	n=224	n=215	n=136	83(37.1%)	79(36.7%)	43(31.6%)	**2.52(1.79-3.54)**	**3.20(2.25-4.55)**	**4.14(2.63-6.52)**
Interaction	n=524	n=551	n=349	192(36.6%)	220(39.9%)	144(41.3%)	0.91(0.55-1.49)	1.18(0.71-1.95)	1.02(0.54-1.92)
Hand Movement and Work Time							Compared with No-Yes		
No-Yes									
No-No	n=586	n=652	n=474	106(18.1%)	105(16.1%)	88(18.6%)	1.56(0.99-2.45)	1.33(0.82-2.16)	0.82(0.44-1.56)
Yes-Yes	n=125	n=123	n=82	32(25.6%)	25(20.3%)	13(15.6%)	**2.45(1.87-3.31)**	**2.94(2.26-3.84)**	**2.52(1.85-3.44)**
Yes-No	n=601	n=612	n=389	211(35.1%)	221(36.1%)	142(36.5%)	**2.41(2.32-5.02)**	**5.57(3.80-8.17)**	**3.95(2.48-6.28)**
Interaction	n=149	n=149	n=95	64(43.0%)	77(51.7%)	45(47.4%)	0.89(0.50-1.60)	1.42(0.78-2.61)	1.89(0.87-4.14)
Physical Effort 3,4,5 and Work Stress 3,4,5							Compared with No-No		
No-No									
No-Yes			n=365			62(17.0%)			**2.08(1.38-3.14)**
Yes-No			n=194			58(30.0%)			**2.13(1.48-3.08)**
Yes-Yes			n=306			93(30.1%)			**3.58(2.39-5.37)**
Interaction			n=175			74(42.3%)			0.81(0.46-1.42)
Physical Effort 3,4,5 and Work Fast							Compared with No-No		
No-No			n=178			32(18.0%)			
No-Yes			n=372			89(23.9%)			1.45(0.92-2.31)
Yes-No			n=151			32(21.2%)			1.72(0.99-2.97)
Yes-Yes			n=338			116(34.3%)			**3.05(1.95-4.78)**
Interaction									1.22 (0.64-2.33)
Physical Effort 3,4,5 and Work Time							Compared with No-Yes		
No-Yes			n=474			97(20.5%)			
No-No			n=82			16(19.5%)			1.24(0.75-2.06)
Yes-Yes			n=389			121(31.1%)			**1.90(1.12-3.20)**

Outcome Measures/Risk Factors				Pain in Arms			Pain in Arms		
n=number of interviewees*				Yes Freq (%)			OR (95% CI)		
Individual Factors	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**	**2002**	**2006**	**2010**
Yes-No			n=95			35(36.8%)			**1.58(1.16-2.15)**
Interaction									0.97(0.47-2.00)

*Number of interviewees with usable data.